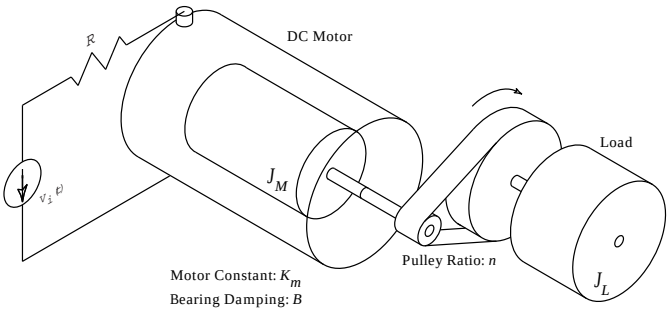
ME 374 System Dynamic Analysis and Design
Mechanical Engineering
Laboratory #1 — Electromechanical System: DC motor & Load

Pre-Lab Problem

Work through this section before going to lab.

Consider the DC motor and inertia load shown in the figure. A voltage source $v_i(t)$ is applied to the motor. The internal resistance of the motor is R. The internal inductance is negligible.



A belt and pulley connect the motor to the rotational load. The parameter values are:

Load inertia:	$J_L = 156 \times 10^{-6}$ kg m^2
Motor rotor inertia:	$J_M = 5 \times 10^{-6}$ kg m^2
Motor resistance:	$R = 3.6$ ohms
Motor Bearing Damping:	$B = 5.1 \times 10^{-5}$ Nms/rad
Motor constant:	$K_m = 0.037$ Nm/Amp
Pulley ratio:	$\frac{\Omega_M}{\Omega_L} = 3.0 = n$

a) Draw the linear graph corresponding to the system.

b) Draw the normal tree.

c) What is the order of the system? (Careful!!)

d) Derive the state equations of the system. Assume that the angular velocity of the *motor rotor* Ω_M is the output.

e) What is the expression for the time constant of the system?

f) Given the parameter values above, what us the numerical value of the time constant?

Laboratory Procedure

a) A tachometer is attached to the back of the motor. A tachometer is a generator that produces voltage in proportion to the velocity of the motor. Connect the tachometer to LabVIEW Input 1. Also, connect the ground (black) lead of the motor to the ground of the power supply.

b) Produce a step input in $v_i(t)$ by quickly connecting the red lead of the motor to the 13.8 v power supply using the banana connector. The free response can be examined by disconnecting the power supply.

c) For the step input, record the angular velocity of the motor using LabVIEW. From this record, determine the time constant of the response. Compare the measured time constant to your theoretical prediction. Can you account for the differences?

d) Disconnect the red lead from the power supply, and record the velocity response. What is the approximate time constant of this response. Is the time constant of this free response equal to that of part c)? Why, or why not?