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

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

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

1. a. On a separate sheet and using the following data, plot the expected step response of the motor-generator system.

   Steady state gain $K$ .......................................................................................... 1.2
   Time constant $\tau$ ........................................................................................... 50 ms
   Initial output voltage $V_0$ ................................................................................... 0 V
   Final input voltage $V_{in}(\infty)$ ........................................................................... 4 V
   Starting time $t_0$ ................................................................................................. 0 s
   Ending time $t_f$ ................................................................................................... 3 s

   b. On the step response plot from above, draw a tangent line at $t = 0$, and determine the intersection of this line with the long-time asymptote.

   c. Using the step response plot from above, determine the time at which the voltage change reaches 63.2% of its maximum value. Mark this point on the plot.

   d. Explain mathematically why $\tau$ is found at this 63.2% point.

2. See Appendix C Method 3. Show that

   $$\tau = \int_0^{\infty} \left[ 1 - \frac{V_{out}(t)}{V_{out}(\infty)} \right] dt$$

   with our first order system that has the equation

   $$V_{out}(t) = V_{out}(\infty) \left[ 1 - \exp\left(-\frac{t}{\tau}\right) \right]$$

3. Variation in $K$ demonstrates what about our model?

4. List the methods used to calculate $\tau$ in this lab.