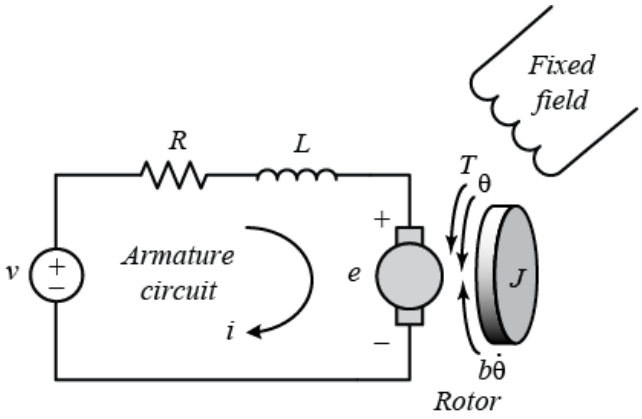
Concordia University

Dept of Computer Science and Software Engineering

SOEN 385 - Control Systems and Applications

Project – DUE: 10 April at 23:59

Speed Control of Electric Motor



The above physical system represents a basic DC Motor (250 HP, 500V, 1750 RPM) equivalent circuit, supplied by a voltage source (V) with the rotor connected to a shaft of angular velocity ($\dot{\theta}$).

The complete model of the system, with rotational speed and current in the armature circuit as the two state variables can be described using the following two equations:

$$\frac{d^2\theta}{dt^2} = \frac{1}{J}\left(K_t i - \mathrm{b}\frac{d\theta}{dt}\right) \quad (1)$$

$$\frac{di}{dt} = \frac{1}{L}\left(-Ri + v - K_e\frac{d\theta}{dt}\right) \quad (2)$$

Where, K_t and K_e are motor constants.

The physical parameters for the system are:

J = Moment of Inertia of the rotor (choose a value between 1.00 and 1.50 kg.m^2)

b = Motor Viscous Friction Constant (choose a value between 1.50 and 2.00 N.m.s)

K_e = Electromotive Force Constant = (choose a value between 1.50 and 2.00 V/rad/sec)

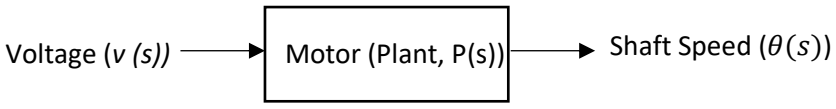
K_t = Motor Torque Constant = (choose a value between 1.50 and 2.00 N.m/Amp)

R = Armature Resistance = 0.06727 Ω

L = Armature Inductance = 0.001882 H

The values of these parameters will be customized (except for R ana L), so each group will have different values. The above-mentioned values are just an example.

A simple block diagram representation of the above system is as follows:



Part 1 (75%)

1. Find the open loop transfer function $G(s) = \frac{\theta(s)}{V(s)}$
2. Analyze the system response to both step and impulse input. Plot the system response and compare the two plots of step and impulse input, what do you observe?
3. Design a PID compensator or a dynamic compensator (Lead or Lag) with your own design criteria (i.e., overshoot, settling time etc.), to get the desired response of the motor (in terms of θ). You may use Root Locus (Matlab, octave, or any other application). Do not forget to include block diagrams of the controlled system. discuss the effect of each of the PID/compensator parameters on the dynamics of the system.
4. Check if the designed compensator meets the selected design criteria specified in step 3) above.

Part 2 (25%)

Build a MATLAB/Octave-based graphical application, with a user-friendly interface to enable the user to change the parameters of the motor or the selected controller/compensator or both and visualize the system response to a unit step input.

Note:
Record and provide all the intermediate steps, plots and results during the design process. Your mark will be based on your understanding of the theory, your analysis of the problem, your effort to tackle the problem and your reasoning for choosing the variables.

The project can be done in a group of up to 6 students.

You will make a demo for the project. All team members should present during the demo.