**ELEC-E8405**

**Electric Drives**

**Assignment 2**

**Modelling and Simulation of DC Motor Drive**

**By**

**Ushnish Chowdhury (101432030)**

**Byri Manoj Srinivasa Perumal (101625232)**

Simulated DC Motor Model:

DC Motor Model

Description automatically generated

A diagram of a machine

Description automatically generated

Testing the simulated DC Motor Model:

A screen shot of a graph

Description automatically generated

1. **Simulate the sequence corresponding to Figure 7. Modify the plotting script so that the per-unit current and the per-unit speed are plotted (use their rated values as base values and do not normalize time). Show this result in your report. Remember to change the axis labels. Explain why there is a very large peak in the current after the voltage step is applied**.

**Ans:**

p.u. plots of current and voltage:

A graph on a white surface

Description automatically generated

1. **Using the analytical motor model, calculate the values for the current and the rotor speed in the steady state, when the voltage and the load torque . Compare these values to your simulation results.**

Ans:

Simulation Results:

A diagram of a machine

Description automatically generated

1. **Limit the rising rate of the voltage to 120 V/0.1 s using the Rate Limiter block. Place this block between the voltage step and the motor model. Simulate the model and show the results in your report. Briefly comment on the current and speed responses.**

**Ans:**

Simulation Results:

A graph with blue lines

Description automatically generated

1. **Augment your simulation model with unipolar PWM and converter models. Simulate the model and show the results in your report. Briefly comment on differences compared to the previous simulation, where an ideal voltage source was assumed.**

**Ans:**

Simulated Model:

**A close-up of a diagram

Description automatically generated**

Simulation Results:

A graph with blue lines

Description automatically generated

1. **Plot the waveforms of the actual current and the synchronously sampled current in the same subplot. Also show the waveform of the voltage .**

**Ans:**

Simulated waveforms:

A diagram of a diagram

Description automatically generated

Testing Model for DC motor with 2DOF PI Current Controller:

**A diagram of a circuit

Description automatically generated**

Derived Waveform:

A graph of a graph

Description automatically generated with medium confidence

1. **Calculate the theoretical rise time of the torque and compare it to the simulated rise time.**

**Ans:**

1. **Tune the speed controller of your simulation model for the closed-loop bandwidth αs = αc/10. Test your model using the square-wave speed reference, whose amplitude is 160 rad/s and frequency is 4 Hz. Generate the rated load torque step at t = 0.3 s. Show results of this simulation in your report. Show also the figures describing the main level of your simulation model and the implemented speed controller.**

**Ans:**

Models used:

**A diagram of a circuit

Description automatically generated**

**A diagram of a computer

Description automatically generated**

Derived outputs:

A diagram of a diagram

Description automatically generated

A graph of a graph

Description automatically generated with medium confidence

A graph of a graph of a graph

Description automatically generated with medium confidence

1. **This problem aims to illustrate the robustness of the closed-loop control scheme against parameter errors. Generally, resistances depend on temperature (about 0.4%/K) and inductances may vary due to the magnetic saturation. Change the actual resistance R in the motor model to 150% of its original value and the actual inductance L to 70% of its original value, but do not change the values in the control system. Simulate the model. Show the results and comment on them in your report. After this problem, restore the parameter values back to their original values.**

**Ans:**

Resistance and Inductance values changed:

A white background with green text

Description automatically generated

Derived outputs:

A diagram of a diagram

Description automatically generated

A graph of a graph

Description automatically generated with medium confidence

A graph of a graph of a graph

Description automatically generated with medium confidence

1. **This problem aims to illustrate the importance of the anti-windup scheme. Remove the anti-windup in the speed controller (but do not remove the saturation of the controller output). Show results of your simulation and comment on them. After this problem, restore the anti-windup method back to the original form.**

**Ans:**

Simulated Model with Anti-windup removed:

A diagram of a machine

Description automatically generated

Simulation results:

A diagram of a diagram

Description automatically generated with medium confidence

A graph of a graph

Description automatically generated with medium confidence

A graph of a graph of a graph

Description automatically generated with medium confidence

1. **Parametrize the speed controller so that it becomes a regular (1DOF) PI controller, while keeping the closed loop poles the same. Furthermore, parametrize the speed controller so that it becomes the proportional controller, while keeping the same reference-tracking performance as that of the original 2DOF PI controller. For both cases, show the simulation results and briefly comment on them.**

**Ans:**

Parameters to convert the existing model to 1DOF PI Controller:

A screenshot of a computer program

Description automatically generated

Waveforms obtained after simulation:

A diagram of a graph

Description automatically generated

A graph of a graph

Description automatically generated with medium confidence

Parameters to convert the existing model to P Controller:

A screenshot of a computer program

Description automatically generated

Waveforms obtained after simulation:

A diagram of a diagram

Description automatically generated

A graph of a graph

Description automatically generated with medium confidence

A graph of a graph of a function

Description automatically generated with medium confidence