Activity Sheet - Week 8 Studio 1

Start	Duration	Activity
0:00	90 mins	(a) Briefing (b) Basic characteristics of a DC motor using Jupyter notebook
1:30	45 mins	Problem solving
2:15	15 mins	Debriefing

Learning objectives

At the end of this session, students will be able

- to explain how a DC motor works,
- to use circuit model for analyzing the characteristics of a dc motor, and
- to solve numerical problems involving dc motor

Tools

- Laptop
- Jupyter notebook with Python installed and the following packages: numpy, scipy, and matplotlib
  - You will use the iPython notebook to simulate different scenarios (download the iPython notebook from Canvas).
  - Follow the example code given and write your own code for each step of the simulation.

Briefing

Lecturer will explain key concepts and solve the following problem showing detailed steps.

Problem:

A 12V, 68W PMDC motor (MD-ENM-50-3Q from Allied Motion Technologies Inc.) connected to a 12 V DC source draws 2 A current and spins at the rate of 6850 RPM when no load is attached to the motor shaft. With a load attached, armature current is increased to 34.6 A current and the speed drops to 2000 RPM.

1. Determine the motor parameters R_a, K_e, and K_t.
2. How much is the friction torque at the bearings? What is the friction coefficient (assuming friction torque is proportional to speed)?
3. What is the maximum torque the motor can produce with 12 V supply?
4. For the operating point of 2000 RPM with $V_a = 12\ V$,
   (a) How much torque is produced by the motor?
   (b) What is the back emf?
   (c) How much power is developed by the motor?
   (d) How much power is delivered to the load?

iPython notebook exercise

1. Download from Canvas the folder

   `Week8_Studio1_Activity_Sheet.rar`

2. Open the iPython notebook.
3. Follow the step by step instructions given in the notebook and complete all activities.

Problem solving exercise

Solve the following numerical problems.

1. A permanent magnet DC (PMDC) motor draws 0.8A current when connected to a 12V dc source and spins at 3600 RPM. If efficiency is 80%, how much torque is produced?

Ans: ≈ 20.4 mNm

2. A PMDC motor draws 1A current from a 12V dc source. Output torque is 0.1 Nm. If power loss in the rotor coil is 1 W, and rotational loss due to bearing friction is 0.8 W, determine

i. the armature (rotor coil) resistance,

ii. the speed, and

iii. the back emf constant of the motor.

Ans: i. 1 Ω, ii. 974 RPM, iii. 0.1 $\frac{V}{rad/s}$

3. The no-load speed and stall current of a PMDC motor powered by a 12V DC source are 3600 RPM and 1 A, respectively. When a load is attached to this motor, it spins at 2500 RPM. Determine at this operating point

i. the back emf, and

ii. the armature current.

Ans: i. 8.33 V, ii. 0.3 A

eLogbook:

1. List of parameters (applied voltage, armature resistance etc.) used in iPython notebook and their values
2. Appropriate graphs from each of the activities in iPython notebook
3. Solutions to the numerical problems of the problem solving exercise