ELEC 344 - 201: Applied Electronics and Electromechanics

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Tutorial 5

1). Consider a permanent-magnet dc motor with the following parameters:

- winding resistance, R_a : 0.35 Ω
- winding inductance, L_a : 1.5 mH
- motor voltage constant, k_E : 0.5 V/(rad/s)
- motor torque constant, k_T : 0.5 Nm/A
- total effective inertia, J_m : 0.02 kg·m^2

The rated torque of this motor is 4 Nm. Plot the steady state torque-speed characteristics for the armature voltage, V_a = 100 V, 60 V, and 30 V.

2). The motor in Problem 1 is driving a load whose torque requirement remains constant at 3 Nm, independent of speed. Calculate the armature voltage V_a to be applied in steady state, if this load is to be driven at 1500 rpm.

3). The motor in Problem 1 is supplied by a switch-mode dc-dc converter that has a dc-bus voltage V_d = 200V. The switching frequency f_S = 25 kHz. Calculate and plot the waveforms for $v_a(t)$, e_a, $i_a(t)$, $i_d(t)$, and $T_{em}(t)$, under the following conditions:

(a) Motoring in forward direction at 1500 rpm, supplying a load of 3 Nm.

(b) Regenerative braking from conditions in (a), with a current of 10 A. (Assume that the inertia is large, and thus the speed changes very slowly.)

4). Assume that the dc-motor of Problem 1 has a wound field. The rated speed is 2000 rpm. Assume that the motor parameters are somehow kept the same as in Problem 1 with the rated field current of 1.5 A. As a function of speed, show the capability curve by plotting the torque and the filed current i_f, if the speed is increased up to twice its rated value.