ELEC 344: Applied Electronics and Electromechanics

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Assignment 3

Due April 16th, 11:59 pm

(Submit a typed report. Include the procedure and steps followed to reach the results. Long derivations can be included in a non-typed appendix.)

1) For a permanent magnet DC motor with the following parameters:

Armature resistance: $\boldsymbol{R_a = 0.3\Omega}$,	Torque constant: $\boldsymbol{k_T = 0.4\frac{Nm}{A}}$,
Armature inductance: $\boldsymbol{L_a = 5mH}$	Total inertia: $\boldsymbol{J_m = 0.025\ kg \cdot m^2}$
Voltage constant: $\boldsymbol{k_E = 0.4\ \frac{V}{rad/sec}}$,	Rated torque: $\boldsymbol{t_{rated} = 5Nm}$

a) Plot steady the state torque-speed characteristic for armature voltages of 120V, 75V and 45V.

b) Calculate the armature voltage required to spin a constant torque load of $\boldsymbol{4Nm}$ at $\boldsymbol{1800\ RPM}$

c) If a switch mode DC-DC converter with an input voltage of 250V, and a switching frequency of 10kHz is employed to drive the motor, calculate and plot the waveforms of the armature voltage and current ($\boldsymbol{v_a}$ and $\boldsymbol{i_a}$) , back-EMF ($\boldsymbol{E_a}$), input current ($\boldsymbol{i_d}$), and electrical torque ($\boldsymbol{T_{em}}$) when motoring in forward direction at $\boldsymbol{1800\ RPM}$, with a constant torque load of 4 Nm.

d) Simulate the scenarios in points a) to c) in PSIM and compare the results with your calculations. Include relevant waveforms and plots obtained from the simulation. **Note:** Although there is no permanent magnet DC motor in PSIM its behavior can be replicated by employing a wound field machine with a constant current source of the rated value. You can use the PSIM simulation file template provided ("Assignment3 DC Motor Simulation Template Without parameters") as a reference. You will have to setup the components parameters according to your calculations and the information provided.

2) A three phase Induction motor with the following parameters:

- $\mathbf{R_1 = 82m\Omega}$,
- $\mathbf{X_{l1} = 19m\Omega}$,
- $\mathbf{R_2 = 70m\Omega}$,
- $\mathbf{X_{l2} = 18m\Omega}$,
- $\mathbf{X_m = 7.2\Omega}$,
- $\mathbf{P_{Losses-mech} = 1.3kW}$,
- $\mathbf{P_{Losses-core} = 1.4kW}$,
- $\mathbf{P_{Losses-misc} = 0}$,
- $\mathbf{\#Poles = 6}$,

is connected in Y configuration to a 50Hz source with 440V per phase.
For a slip of 0.04, determine:

a) The phase current, and copper losses at the armature.
b) The air-gap power, and the power converted to mechanical
c) The induced and load torque
d) The overall motor efficiency
e) The motor speed in RPM and rad/sec