COLORADO SCHOOL OF MINES
ELECTRICAL ENGINEERING DEPARTMENT

EENG577 Advanced Electric Machine Dynamics for Smart-Grid Systems

M6 Project - Induction Motor Drive

Consider a three phase, 15 hp, 440 V, 60 Hz, 8 pole wound rotor induction motor whose machine parameters were determined from blocked rotor and no-load tests and resulted in the following values:

Stator resistance $r_s = 0.52\ \Omega$
Stator phase leakage inductance $L_{ls} = 3.05$ mH
Phase magnetizing inductance $L_m = 106.1$ mH
Rotor phase resistance $r_r = 0.634\ \Omega$
Rotor phase leakage inductance $L_{lr} = 3.053$ mH
Assume an effective turns-ratio of one.

1. Write down the state space model of the induction motor in the natural abc frame of reference using the notations developed in the lecture. Use the values given above to determine the parameters of the abc frame of reference state space model.

2. The induction motor described above is used with a dc-source inverter-bridge as shown in Figure (1). Use the abc frame state models *preferably* with Simulink or with MATLAB to predict the performance characteristics of this motor drive system under the following conditions:

- The inverter has 180° conduction periods, Figure (2)
- The motor is operating at a slip of 0.04
- The dc supply has a value of 564 V

Run your model till you achieve steady state conditions and plot the following:

- Machine stator phase voltages
- Machine stator L-L voltages
- Stator phase currents
- Machine developed torque

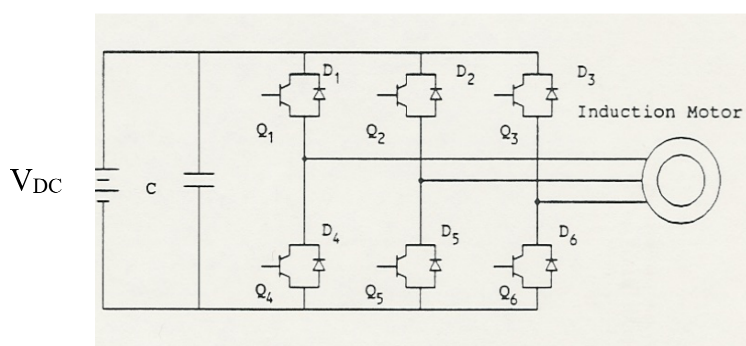

Fig. (1): Schematic of Inverter-fed Induction Motor System

3. If the machine drive system is operated with a 120° conduction period, and if it is needed to supply the same torque, then the dc voltage supplied to the inverter would have a different value. The difference is introduced to obtain an inverter output voltage whose fundamental ac component, v_{rms}, is equal in both cases. That is, for the motor inverter system to deliver an output power for the 120° e conduction period similar to that for the 180°e conduction period, the dc voltage level should be changed.

   Show that the dc voltage can be related to the following expressions:

   - For 180° conduction period: $V_{dc} = \frac{\sqrt{2}\pi}{2\sqrt{3}} v_{rms}\,(L\text{-}L)$
   - For the 120° conduction period: $V_{dc} = \frac{\sqrt{2}\pi}{3} v_{rms}\,(L\text{-}L)$

4. Use the relationships given above to calculate the dc voltage required. Also repeat part (2) for the same slip at a conductance period of 120°, see Figure (3).
   – Tabulate your results for both cases to compare the line-to-line voltage peak values, phase current peak values, average torque value.
   – Discuss your results and comment on the effects of 180° e and 120° e inverter conduction periods on motor performance.

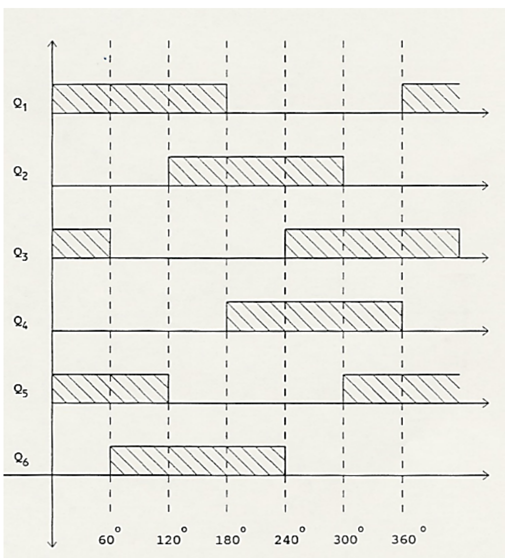

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Fig. (2): Inverter Switching Sequence for 180° e Conduction Period

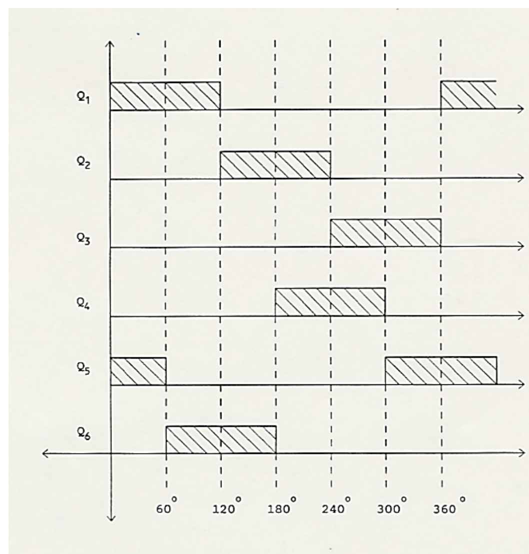

Fig. (3): Inverter Switching Sequence for 120° e Conduction Period

5. As a Team, complete the following table and include with your submission:

Tasks	**Name of Member #1:**	**Name of Member #2:**	**Name of Member #3:**
Formulations & Calculations	% Contribution:	% Contribution:	% Contribution:
MATLAB/Simulink Coding	% Contribution:	% Contribution:	% Contribution:
Report Writing	% Contribution:	% Contribution:	% Contribution:
Overall % Contribution/Member	% Contribution:	% Contribution:	% Contribution:

Notes:

- **The report must be typed and neat and all plots are properly labeled and easy to read.**
- **The body of the report should include, for each part, all relevant formulas. If it was implemented in Matlab/Simulink, you should briefly describe how that was done.**
- **Discuss your results.**
- **Include the listing of your program.**
- **Follow the rubric closely.**
- ***As a group project,*** *you can discuss the problem with other students in EENG 577, however, each Team should work independently.*