Fall 2005 EE595S
Homework Assignment Number 6

Note: Since this will not be collected, there is no due date. It is recommended that this be completed before we start the next set of lecture notes.

Problem 1
A 4 pole volts-per-hertz induction motor is operating in the steady-state at a frequency of 50 Hz. At a given instant, the a- to b-phase line-to-line voltage is 200 V and the b- to c-phase voltage is -60 V. The a-phase current is 50 A, and the b-phase current is -25 A (at that instant). The machine is wye connected and has a stator resistance of 0.1 Ohm. What is the electromagnetic torque? Hint: think about (14.2-8) through (14.2-11).

Answer: 51.73 Nm

Problem 2
Derive an expression for the value of radian slip frequency which yields the most torque for a given rotor current ?

Answer: You should be able to show that as the slip frequency decreases, the required rotor current can be reduced w/o bound. Thus, you should use the smallest value that won't saturate the machine (14.3-10).

Problem 3
Consider the rotor flux calculator shown in Fig. 14.5-1 of [1], with the 50 Hp machine parameters, also from [1]. Take these parameters to be the 'true' parameters. At a given instant of time the q-axis magnetizing flux linkage, d-axis magnetizing flux linkage, q-axis stator current and d-axis stator current are 0.35 Vs, -0.35 Vs, 50 A, and 20 A, respectively, all in the stationary reference frame. Neglecting the low pass filter, what is the d-axis rotor flux and the position of the synchronous reference frame.

Answer: The d-axis rotor flux in the synchronous ref. frame is 0.493 Vs. The position of the synchronous reference frame is 2.489 rad.

Problem 4
Consider Problem 3. Take the estimated parameters to be:

$$L_{lr,est}' = 1.5 L_{lr}'$$
$$L_{M,est} = 1.2 L_M$$

and assume the cutoff frequency of the low pass filter is 1 KHz. If the electrical frequency is 100 Hz, compute the estimated d-axis rotor flux and position of the synchronous reference frame. Compare to problem 3.

Answer: The d-axis rotor flux is estimated at 0.488 Vs (a 1.1% error); the position of the synchronous reference frame is estimated iat 2.458 rad (a 0.894 degree error).

Problem 5
Problem 9 from Chapter 14 of [1].

Starting point for answer: Think about the voltage equation in the stationary reference frame.

Problem 6
Problem 12 from Chapter 14 of [1].

Answer: You will basically end up interchanging d and q.

[1] *Analysis of Electric Machinery and Drive Systems*, P.C. Krause, O. Wasynczuk, S.D. Sudhoff