COLLEGE OF ENGINEERING & TECHNOLOGY

Department : Electrical & Control Engineering

Lecturer : Dr. Maged Mahmoud

Course : Electrical Drives II

Course Code : EE 522 Marks : 40

Date : 3/6/2015 Time : 2 hour

Final Exam

Answer all the following questions:

Question 1: [A24 | B2]

(a)Convert the functions F_{as}, $F_{bs}$and F_{cs} into the *dq0* frame;

$$F_{as} = \text{Cos t}, \quad F_{bs} = 0.5\ \text{t}, \quad F_{cs} = -\sin \text{t}$$

- Calculate the values of F_{ds}, $F_{qs}$and F_{0s} at t = $\pi/2$ seconds given that the abc to dq transformation is performed in the stationary reference frame with $\theta = 0°$. **[4 marks]**

(b)Figure 1 shows the dq equivalent cicuits of the induction machine with ω representing the reference frame speed.

- Starting with the circuits in figure 1, drive the dq equivalent circuits for a wound rotor synchronous machine with damper windings, and show which reference frame should be used for the analysis of synchronous machines. **[6 marks]**

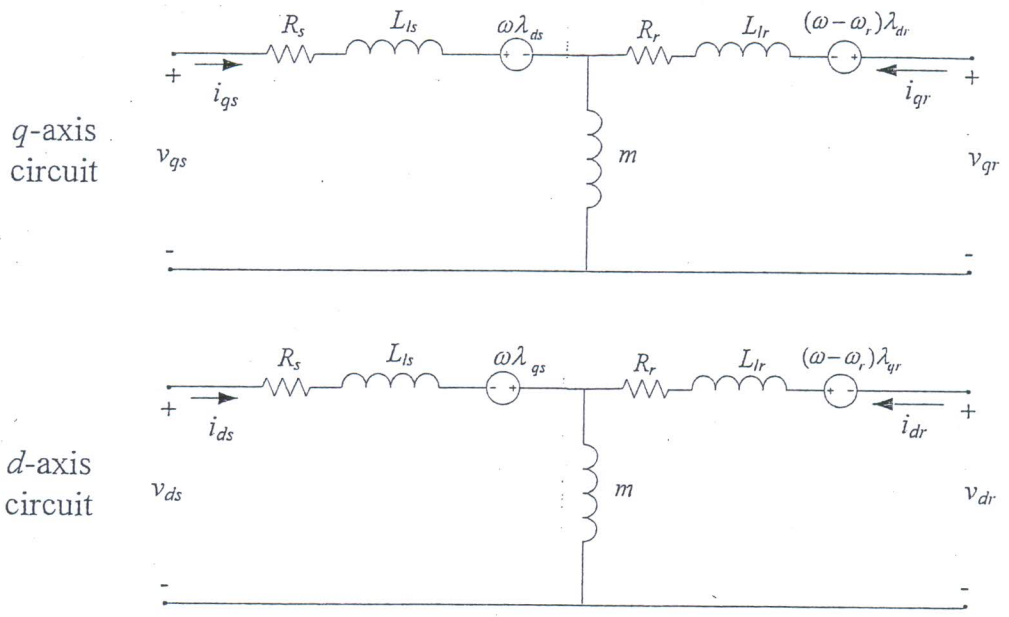

Figure 1: dq equivalent cicuits of the induction machine

Members of course Examination Committee:	Signature:	Date:
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Question 2:

[A24 | B3]

(a)Explain an experimental test procedure for measuring the following dq model parameters of a permanent magnet synchronous machine.

- Stator resistance R_s
- Magnet flux linkage λ_m
- d axis inductance L_d

[5 marks]

(b)The output torque of an induction machine analyzed in the dq frame can be represented by,

$$T_e = \frac{3}{2}\frac{P}{2}\frac{L_m}{L_r}(\lambda_{dr}\, i_{qs} - \lambda_{qr}\, i_{ds}) \qquad (1)$$

- Using equation 1, explain the basic operating principle of field oriented control of induction motors, and show how the induction motor can be controlled in a similar fashion to a separately excited DC motor.
- What is the advantage of field oriented control over the conventional v/f control of induction motors?

[5 marks]

Question 3:

[A4 | B2]

(a)Draw the output voltage vectors under the six basic switching states of a space vector controlled three-phase inverter.

[4 marks]

(b)Consider a three phase inverter controlled with space vector modulation technique. The inverter has a DC bus voltage of 600v and the inverter switching frequency is 8 kHz. It is required to generate a voltage vector $\bar{v}_s$ with magnitude of 100v at an angle 45° from phase *a*.

- Determine which switching states are needed to generate $\bar{v}_s$.
- Calculate the time duration of each switching state.
- Draw one period of the switching sequence to generate $\bar{v}_s$, and indicate the duration of every switching state in the diagram.

[7 marks]

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