M. POWER ENGG. EXAMINATION, 2008

(1st Semester)

ANALYSIS OF ELECTRICAL MACHINES

Time : Three hours Full Marks : 100

Use a separate Answer-Script for each part.

PART–I (70 marks)

*Answer any **four** questions.*
(2 marks for neatness)

1. Write the flux linkage and voltage equations of a Kron's primitive machine and obtain its impedance matrix.

   Also obtain an expression for electrical torque of the Kron's primitive machine. Show that no torque is produced by interaction between the flux and current on the same axis. 17

2. Derive the transformations for currents between a rotating balanced 2-phase (α , β) winding and a pseudo-stationary two phase (d, q) winding. Assume equal turns on all coils. Show that the transpose of current transformation matrix is equal to its inverse.

For steady state balanced operation with

$i_\alpha = I_m Cos(\omega t + \varphi)$

and $i_\beta = I_m Sin(\omega t + \varphi)$

determine the primitive coil current i_d and i_q, and show that these are steady dc values. 17

3. What are the various basic parameters of a synchronous machine ?

Derive expressions for armature mutual inductances of salient pole synchronous machine. Explain with diagrams. 17

4. Deduce Park's transformations relating the three phase currents of a synchronous machine to is corresponding d–q axes currents and its inverse.

What is meant by 'power invariance' ? If current connection matrix [C] is given, find the new voltage matrix and the transformed impedance matrix in case the currents are :

(i) instantaneous, and

(ii) expressed in complex notation. 17

5. A symmetrical sudden 3-phase short circuit is applied to the terminals of an excited salient pole synchronous generator (without damper bars) running at synchronous speed and at no load. Develop an expression for the armature current in any instant of time following the short circuit, in case armature transformer voltages and armature resistances are neglected. 17

6. Develop a suitable model of a salient pole synchronous machine (without dampers) in d–q reference frame.

Starting from the impedance matrix of the same, derive the phasor voltage equation under balanced steady state operation. Hence draw phasor diagrams for both motor and generator. 17

PART–II (30 marks)

*Answer any **three** questions.*

7. Incorporating the effect of saturation and considering a primitive physical Model, derive the expression for flux and voltages for the model. 10

8. Explain with diagram the universal field oriented current controller and explain the machine performance under constant air gap flux situation. 10

9. Find the expression of current in the event of a sudden short circuit for a 3 phase induction motor. Assume the reference frame is attached to the rotor and transient begin on no load. 10

10. Sketch and explain with block diagram the universal vector decoupling control of an Induction motor using Rotor Field oriented control (I type). 10

11. Using space phasor equations find the transient and subtransient inductances of an induction motor. 10

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