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Invigilator's Signature : .....

## CS/M.Tech(EE-OLD)/SEM-1/PEM-102/2012-13 2012 ELECTRICAL MACHINE ANALYSIS

*Time Allotted* : 3 Hours

Full Marks: 70

The figures in the margin indicate full marks. Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* questions.  $5 \times 14 = 70$ 

- 1. a) Draw the Kron's primitive machine model of a long shunt connected *d.c.* compound motor.
  - b) Derive the expression of torque for the Kron's primitive machine.
  - c) Show that no torque is produced due to interaction between the flux and current on the same axis.

2 + 9 + 3

2. a) If *A* is one Reference Frame and *B* another, show that

 $\left(\begin{array}{c}A\mathbf{K}B\end{array}\right)^{-1}=\begin{array}{c}B\mathbf{K}A\end{array}.$ 

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- b) Stationary circuit variables are given by  $v_{as}$ ,  $v_{bs}$  and  $v_{cs}$  and are to be referred to following reference frames
  - i) The stationary two axes reference frame having axes  $\alpha$  and  $\beta$ .
  - ii) The arbitrarily rotating reference frame having axes *d* and *q*.

Derive the transformation and inverse transformation matrices for both of the cases. Also write matrices if the axes of the reference frames interchange their positions. 6 + (4 + 4)

- The phases of a 3-phase balanced symmetrical stationary circuit consist of equal resistance, equal inductances and equal capacitances connected in series. the phases are not coupled. Write the voltage equations in the arbitrary reference frame and draw the equivalent circuit.
- 4. a) Derive the state equations for a separately excited *d.c.* motor.
  - b) A separately excited *d.c.* machine is operating with no load and fixed field current. The armature resistance and inductance are small and can be neglected. Assume Damping Constant, B=0. Express the transfer function between  $i_a$  and  $v_a$ . Show that the motor appears as a capacitor to  $v_a$ . 7+7

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- 5. a) Derive the Park voltage equations for a 3-ph synchronous machine. Use suitable notations for the variables and show their corresponding transformation as required during derivation.
  - b) Why rotor reference frame is chosen instead of arbitrary reference frame for derivation. 11 + 3
- 6. Choosing suitable reference frame derive the steady state torque of synchronous machine. 14
- 7. In arbitrary reference frame derive the equivalent circuit of
   3-phase symmetrical Induction Motor and determine
   torque. 10 + 4
- 8. For a 3-phase symmetrical Induction Motor, develop the equivalent circuit for steady state operation. Also derive the expression of torque there from.
  7 + 7

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