Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH(EE)/SEM-1/EDPM-103/2012-13

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 Q. No. 1 and any *four* from the rest. 5 × 14 = 70

1. Answer any *seven* of the following : 7 × 2 = 14

   i) What do you mean by generalised theory of machine ? What is its significance ?

   ii) What are quasi holonomic reference frame and non-holonomic reference frame ?

   iii) What is quasi-static coil ? What is its significance ?

   iv) What are transformer and rotational *emf* ? Give the necessary phasor diagrams.

   v) What is primitive machine ? Why is it called Kron's primitive machine ?

   vi) What do you mean by 'Conduction Machine' & 'Induction Machine' ?

   vii) What are the advantages of using *VVV f* Drive ?

viii) What do you mean by 'Constant Power' machine ?

ix) Give the definition of 'mechanical time constant' & 'electrical time constant' in *dc* machine.

x) What are the procedures for controlling speed of *dc* motor ? Which is preferable ?

2. a) Obtain the expression for the electrical torque of the Kron's primitive machine.

   b) Show that no torque is produced by interaction between the current and flux on the same axis. 12 + 2

3. a) Derive the Transformation from 3-phases a, b, c on Rotor to $\alpha, \beta, 0$ when α, β are the axis of rotor reference frame rotating with rotor.

   b) What do you mean by Power invariance transformations ? Give proper justification with taking an example.

   c) What are Clarke Transformation & Park Transformation ? 7 + 5 + 2

4. a) For transformation between two reference frames,

   $f^{y}_{qd0s} = {}^{x}K^{y} f^{x}_{qd0s}$

   Show that ${}^{x}K^{y} = K^{y}_{s}(K^{x}_{s})^{-1}$

   Where x = reference frame to which variables are being transformed, y = reference frame to which variable are being transformed.

   b) Derive the expression for ${}^{x}K^{y}$ in the terms of space angle between the reference frames.

   c) Prove that ${}^{x}K^{y} = ({}^{y}K^{x})^{-1}$. 5 + 5 + 4

5. Derive the expression of Resistive element and Inductive element where stationary circuit variables transformed to the arbitrary reference frame. 6 + 8

6. a) Develop the Time-domain block diagram of a permanent magnet DC motor with connected mechanical load.

   b) Derive the time domain equation for motor speed (ω) if load torque is zero ($T_L = 0$).

   c) Develop the Time-domain block diagram of a permanent magnet DC motor with $T_L \neq 0$ and step change in load torque while motor terminal voltage (V_t) is kept constant. 5 + 4 + 5

7. a) Derive the equivalent circuits for a 3-phase symmetrical Induction motor with all circuit variables referred to arbitrary rotating reference frame. Also show the transformations and write all corresponding voltage equations.

   b) Derive the expression of torque in terms of transformed variables referred to arbitrary rotating reference frame. 12 + 2

8. a) Derive the Park's voltage equation for a 3-phase round rotor non-salient poly type synchronous machine. Use suitable notations for the variables and show their corresponding transformations as required during derivation.

   b) Why is the rotor reference frame preferred for the analysis of the synchronous machine compared to the other reference frames ? 12 + 2

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