Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2014**

**Subject code: 714504N** **Date: 24-06-2014**

**Subject Name: Modeling and Analysis of Electric Machines**

**Time: 02:30 pm - 05:00 pm** **Total Marks: 70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

**Q.1** **(a)** The energy stored in the coupling field of a magnetically linear system with two electrical inputs may express. **07**

$$W_f(\lambda_1, \lambda_2, x) = \frac{1}{2}B_{11}{\lambda_1}^2 + B_{12}\lambda_1\lambda_2 + \frac{1}{2}B_{22}{\lambda_2}^2$$

Express $B_{11}$, $B_{12}$, $B_{22}$ in terms of Inductances $L_{11}, L_{12}, L_{22}$.

**(b)** Transform the variables of stator reference frame into the synchronously rotating reference frame. **07**

**Q.2** **(a)** Explain electromechanical energy conversion process in electric drive. **07**

**(b)** The Transformation matrix is given as **07**

$$K_s = \sqrt{\frac{2}{3}}\begin{bmatrix} \cos\theta & \cos(\theta - \frac{2\pi}{3}) & Cos(\theta + \frac{2\pi}{3}) \\ Sin\theta & Sin(\theta - \frac{2\pi}{3}) & Sin(\theta + \frac{2\pi}{3}) \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$$

Show that $(K_s)^T = (K_s)^{-1}$

**OR**

**(b)** For a 4 pole, 3 phase symmetrical induction machine, derive the voltage equations in machine variables. Then derive the expression for the electromagnetic torque in stator reference frame. **07**

**Q.3** **(a)** The input power to DC shunt motor during rated load is 110 W. The rotor speed is 1990 r.p.m. and armature voltage is 120 V. The armature resistance is 2 ohm and field resistance is 200 ohm. Calculate no load speed of motor. **07**

**(b)** Explain computer simulation of 3 phase 2-pole Y connected salient pole synchronous machines. **07**

**OR**

**Q.3** **(a)** Prepare time domain block diagram of D.C. shunt motor according to linearized equations. **07**

**(b)** Explain computer simulation of 3 phase 2-pole induction machine with unbalanced stator impedance condition. **07**

**Q.4** **(a)** Write voltage equation referred to stator winding of 3-phase, 2 pole, Y connected synchronous generator into abc variables. The synchronous generator has one field winding **07**

and one damper winding on d axis and two dampers winding on q axis of rotor. Express voltage equations into rotor reference frame where current as independent variables.

**(b)** Develop equivalent circuit of an induction machine in the arbitrary reference frame. **07**

**OR**

**Q.4** **(a)** Write the voltage equations in the capacitive and resistive elements together. Determine the voltages in $qd_o$ frame and hence obtain the impedance matrix into $qd_o$ frame. **07**

**(b)** Derive the unbalanced stator variables into arbitrary reference frame. Comment on the transformed variables with respect to speed of reference frame. **07**

**Q.5** **(a)** Explain angle of rotor and angle between rotors for synchronous machines. **07**

**(b)** Derive the Torque Speed Characteristic of PM BL DC machine and define common mode operation. **07**

**OR**

**Q.5** **(a)** Derive the voltage and torque equations in machine variables for PM brushless DC machines. **07**

**(b)** Why is the synchronous machine variables transformed into rotor reference frame? Define speed current in transformation of capacitive circuit into arbitrary reference frame. **07**

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