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Question Paper Code : 83295

M.E. DEGREE EXAMINATION, JANUARY 2014.

First Semester

Power Systems Engineering

PX 7101 — ANALYSIS OF ELECTRICAL MACHINES

(Common to M.E. Power Electronics and Drives)

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why the electro–magnetic–mechanical systems are nonlinear in nature?

2. In a doubly excited cylindrical rotary system which inductance takes part in the development of torque? Explain in brief.

3. State whether the transient response of electro-mechanical systems is step or ramp or exponential? Justify your answer.

4. The three phase currents drawn by a three phase induction machine is given by, $l_{as} = l_{\max 1}\cos\omega_e t$; $l_{bs} = l_{\max 2}\cos(\omega_e t - 2\pi/3)$; $l_{cs} = l_{\max 3}\cos(\omega_e t + 2\pi/3)$. State whether the d-q transformation theory can be applied on these current components.

5. A separately excited DC motor requires 100 w at full load. The full-load speed is 2000 rpm and the armature voltage is 100 V. Armature coil resistance is 2 Ω and field coil resistance is 200 Ω. Calculate the no-load speed of the motor.

6. Briefly explain why a rotating commutator winding may be represented by a pseudo-stationary coil along the brush axis in a DC machine.

7. In a three-phase induction machine if the three-phase stator variables are transformed into two-phase variables in a synchronously rotating reference frame, then how these variables will appear?

8. Write down the torque equation of a three-phase induction machine using only its stator variables.

9. What is the purpose of using damper winding in a synchronous machine?

10. What is called critical clearing angle in a synchronous machine?

PART B — (5 × 16 = 80 marks)

11. (a) (i) A simple relay has an air gap of length 1.0 mm and effective cross-sectional area 1000 mm^2. The magnetizing coil consists of 1000 turns of wire carrying a current of 200 mA. Calculate the energy stored in the air gap. The reluctance of the ferro–magnetic part of the magnetic circuit may be neglected. (8)

(ii) From the principle of coenergy deduce the expression for developed torque in a singly excited system. (8)

Or

(b) An electromagnetic structure is characterized by the following inductance :

$$L_{11} = L_{22} = 4 + 2\cos 2\theta; L_{12} = L_{21} = 2 + \cos\theta$$

Neglecting the resistances of the windings, find the torque as a function of when both the windings are connected to the same ac voltage source such that $V_1 = V_2 = 220\sqrt{2}\ \sin 314t$.

12. (a) Obtain the torque and voltage equations of the permanent magnet DC machine. (16)

Or

(b) A DC shunt motor is started using a three-point starter. Obtain the transient response characteristics

(i) current (vs.) time and

(ii) speed (vs.) time from starting to free running condition operated under no-load. Derive the equations that are used in studying the transient response. (16)

13. (a) Compare and contrast the d-q theory applicable to three-phase induction motor with the respect to the analysis of performance of a DC motor. (16)

Or

(b) From the physical concepts describe how the transformation may be used to represent a three-phase synchronous machine by a primitive commutator machine. (16)

14. (a) Using the d-q theory deduce the voltage equation of three-phase induction motor in stationary reference frame. (16)

Or

(b) A six-pole, 50 Hz, three-phase induction motor with a star connected wound rotor has a standstill slip-ring voltage of 150 V. The rotor resistance and reactance are 0.2 Ω/phase and 1.2 Ω/phase respectively. Assume that the stator resistance and leakage reactance are negligible.

Draw the complete torque (vs.) slip characteristics of the motor by determining

(i) the torque at starting and

(ii) the maximum torque and the corresponding fractional slip.

Further determine the rotor phase current values at those conditions. (16)

15. (a) Apply park's transformation on a three–phase synchronous machine and obtain its voltage and torque equations. (16)

Or

(b) A synchronous generator experiences a sudden three phase short circuit fault at its terminals. Obtain the voltage equation under short circuited condition and draw its dynamic characteristics. (16)
