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Question Paper Code : 41058

M.E./M.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2018.

First Semester

Power Systems Engineering

PX 5151 — ANALYSIS OF ELECTRICAL MACHINES

(Common to Power Electronics and Drives)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Develop from the fundamentals, the basic two-pole machine representation for the following : (a) Kron's primitive machine and (b) DC shunt machine with interpoles.

2. Distinguish between transformer voltage and speed voltage in the armature of an electrical machine.

3. Define the term "invariance power" as applied to electrical machines.

4. Obtain the armature current equation for primitive representation of DC long shunt cumulatively compound motor.

5. Give the performance equation of the Ward-leonard system of the speed control of a DC motor.

6. Write an expression for reactive power of a non-salient pole Synchronous machine in terms of torque angle.

7. A 1000kw, 6.6 kV, 50 Hz, 20 pole Synchronous motor has the following parameters : Total moment of inertia (J) : 2480 kg-m^2 Synchronising power coefficient (P_s) : 40 kW/elec. degree, Damping power coefficient (K_d): 2 kW/elec degree/s. Calculate the undamped natural frequency, natural period of oscillation and the damped natural frequency of oscillations.

8. Give the voltage equations in matrix form for double cage Induction motor.

9. Specify expression for torque developed by a 1-phase series motor.

10. Mention the procedure to be adopted for the analysis of inter-connected machines.

PART B — (5 × 13 = 65 marks)

11. (a) Write down the voltage equation for generalized electrical machines and derive the equation for power loss in the winding and also the equations for the electromagnetic torque. (13)

Or

(b) Explain the importance of transformation with an example machine. (13)

12. (a) (i) Explain the transformations necessary to convert a 3-phase winding on the rotor into an equivalent 2-phase winding. (3)

(ii) A 3-phase, 4-pole, 50 Hz squirrel cage Induction motor develops a torque of 300 Nm at a rated phase voltage of 240 V. Will the Induction motor operate if the 3-phase winding on the stator were replaced by a 2-phase winding for which the number of poles, effective number of turns/phase and the conductor size remain same? Calculate for the 2-phase motor (1) rated phase voltage and (2) torque developed for the rated phase voltage from a 2-phase 50Hz supply. (10)

Or

(b) Obtain the expression for the current transient in the armature of a suddenly short circuited separately excited DC generator. State the assumptions made. (13)

13. (a) (i) With the help of necessary equations explain the method of analyzing transient behavior of Synchronous machine. (7)

(ii) Derive the equations for frequency of oscillations with and without damper winding. (6)

Or

(b) (i) Mention the transformation variable from stationary to arbitrary reference. (7)

(ii) Brief about the variable observed from several frames of reference with an example. (6)

14. (a) A 3-phase Induction motor has the following per phase parameters referred to stator: Stator resistance = 0.3Ω; Rotor resistance = 0.45Ω; Stator and Rotor leakage reactance = 2.1Ω, each and Magnetizing reactance = 30.0Ω. Find out the parameters of an equivalent 2-phase Induction motor if its per phase turns are :

(i) same as that of the 3-phase Induction motor.

(ii) 3/2 times that of the 3-phase Induction motor.

(iii) root of 3/2 times of the 3-phase Induction motor. (13)

Or

(b) From the electrical performance equations of 3-phase Induction motor derive the steady State torque equation. (13)

15. (a) (i) Draw the phasor diagram for salient pole Synchronous generator and derive the equation for power developed. State the assumptions made. (6)

(ii) A salient pole Synchronous generator has the following pu parameters: X_d = 1.2, X_q = 0.8, R = 0.025. Compute the excitation voltage on pu basis when the generator delivers rated KVA at 0.8 pf lagging and at rated terminal voltage. (7)

Or

(b) Explain the importance of digital computer simulation with example and mention some of the software used for this applications. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A seperately excited DC generator is connected to a load resistance R_L. The generator is driven at constant speed but the voltage source connected to field winding is such that the field current is given by $i_f = I_{fo} + I_f \sin \omega t$. Obtain expressions for (i) load current (ii) torque and (iii) power converted from mechanical to electrical. Neglect armature inductance.

Or

(b) A 3-phase, star connected, 400 V, 50 Hz, 4-pole Induction motor has the following constants in ohm per phase R_s = 0.8; R_r = 0.3; X_s = X_r =2.0; X_m = 48.0. If the motor is operated at a reduced voltage and frequency of 200 V, 25 Hz, compute

(i) current and pf at the instant of starting and maximum torque. Compare the result with normal values.

(ii) starting and maximum (pull-out) torques and compare with normal values.

Under normal operation and at rated load, the motor has a slip of 0.03; Find the value of slip, if the motor is now operated at half the voltage and half the frequency at the original rated load.

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