

Reg. No. :

Question Paper Code : 11185

M.E./M.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

First Semester

Power Electronics and Drives

PX 5151 — ANALYSIS OF ELECTRICAL MACHINES

(Common to M.E. Power Systems Engineering)

(Regulation 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the principles of Electromechanical energy conversion.
2. A two winding magnetically coupled system has N_1 turns in primary and N_2 turns in secondary windings. Show the relationship between magnetizing inductances L_{m1} and L_{m2} of the windings respectively.
3. Give the expression for transfer functions of DC motor.
4. Under what condition the mechanical power developed in a dc motor will be maximum?
5. Mention different type of reference frame theories.
6. Sketch the arbitrary reference-frame equivalent circuit for 3 ϕ RL circuit.
7. What do mean by steady state operation of symmetric induction machine?
8. Give the expression for torque of induction machine.
9. What is rotor angle?
10. What is called Kron's primitive machine?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive the general expression for torque in terms of energy and co-energy of a doubly excited rotating electro-magnetic system. (8)
- (ii) Derive the general expression for force in terms of energy and co-energy of a singly excited linear actuator. (5)

Or

- (b) Two coupled coils have self and mutual inductance of over a certain range of linear displacement x .

$$L_{11} = 2 + \frac{1}{2x} \quad L_{22} = 1 + \frac{1}{2x} \quad L_{12} = L_{21} = \frac{1}{2x}$$

The first coil is excited by a constant current of 20 A and the second by a constant current of -10 A. Find:

- (i) Mechanical work done if x changes from 0.5 to 1 meter.
- (ii) Energy supplied by each electrical source. (13)
12. (a) Draw and explain the speed torque characteristics and VI characteristics of the following dc machines in motoring and generating modes. (13)
- (i) Series
- (ii) Shunt
- (iii) Compound.

Or

- (b) Obtain the torque and voltage equations of the permanent magnet DC machine.
13. (a) For a three phase symmetrical stator windings of induction machine, obtain the voltage equations in arbitrary reference frame and also show their d-q equivalent circuits.

Or

- (b) (i) Derive the formulation of transformation of 3 phase variables to a stationary reference frame.
- (ii) Apply qd0 transformation to series RL circuit and derive an expression for current and voltage (1) with mutual inductance (2) without mutual inductance.

14. (a) From first principles, derive the voltage and torque equations of a three phase symmetrical induction machine.

Or

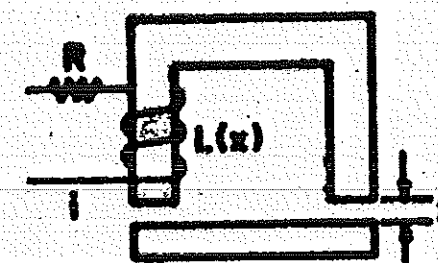
- (b) For a 2 pole 3 phase wye connected salient pole machines, derive the expressions for per phase winding inductances.
15. (a) Obtain the dynamic model of three phase synchronous machine using park's transformation.

Or

- (b) Briefly explain the generalized theory of rotating electrical machines.

PART C — (1 × 15 = 15 marks)

16. (a) The lifting magnetic system shown in figure below has a square cross section of $6 \times 6 \text{ cm}^2$. The coil has 300 turns and a resistance of 6 ohms. Neglect reluctance of the magnetic core and field fringing in the air gap.
- (i) The air gap (X) is initially held at 5 mm and a dc source of 120 V is connected to the coil. Determine the stored energy and the lifting force. (8)
- (ii) The air gap (X) is again held at 5 mm and an ac source 120 V (rms) at 50 Hz is connected to the coil. Determine the average value of the lift force and comment on the results. (7)



Or

- (b) A 4-pole, 7.5-hp, 3-phase induction motor has following parameters: $r_s = 0.3 \Omega$, $L_{ms} = 0.035 \text{ H}$, $r_r' = 0.15 \Omega$, $L_{lr}' = 0.0015 \text{ H}$, $L_{lr}' = 0.0007 \text{ H}$. The machine is supplied from a 110 V line to neutral 60 Hz source.
- (i) ω_r is held at zero. Calculate T_e and express I_{as} , I_{bs} (instantaneous), and I_{cs} assuming an *abc* sequence. (ii) Repeat (i) if $\omega_r = \omega_e$ and friction and windage losses are neglected. (15)