C1b 20/12 FN

Reg. No. :

Question Paper Code : 71087

M.E./M.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

First Semester

Power Electronics and Drives

PX 5151 – ANALYSIS OF ELECTRICAL MACHINES

(Common to : M.E. Power Systems Engineering)

(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Compare energy and co-energy.
2. Give examples for singly excited and doubly excited systems.
3. For the electromechanical device shown in Figure 1, find the value of torque.

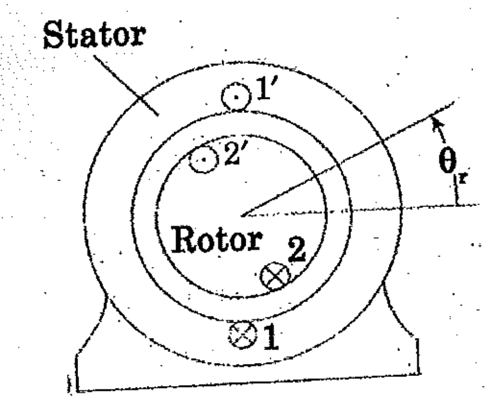

Figure 1. Electromechanical device

4. Why dynamic response of a DC motor is better in comparison with an AC motor ?
5. What are the advantages of reference frame transformation ?
6. Write the desired transformation matrix for transforming variables in 'x' frame into 'y' frame.
7. Relate the dq voltage expressions and phase voltages for an induction motor under balance supply operation.

8. What are the different types of frames used for analysis in an induction motor ?

9. What is the need for damper windings in synchronous motor ?

10. Explain equal area criterion.

PART – B (5×13 = 65 Marks)

11. a) Obtain energy, co-energy and force for $\lambda = x^2 i_1^{\,4} + x$. (5+5+3)

(OR)

b) In two coupled coils have self and mutual inductance of $L_{11} = 2 + 1/2x$; $L_{22} = 1 + 1/2x$; $L_{12} = L_{21} = 1/2x$ over a certain range of linear displacement x. The first coil is excited by a constant current of 20 A and the second by a constant current of – 10 A. Find :

a) Mechanical work done if x changes from 0.5 to 1 m.

b) Energy supplied by each electrical source in part (a)

c) Change in field energy in part (a) (5+5+3)

12. a) Obtain the speed transfer function for a PMDC motor under no-load operation.

(OR)

b) Explain the time domain block diagram of separately excited DC motor.

13. a) Prove that i) $(K_s)^T = (K_s)^{-1}$; ii) $f_{as}^{\,2} + f_{bs}^{\,2} + f_{cs}^{\,2} = f_{qs}^{\,2} + f_{ds}^{\,2} + f_{0s}^{\,2}$. K_s matrix is given as : (8+5)

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

(OR)

b) Prove that reference frame transformation is power invariant.

14. a) Obtain the dq0 equivalent circuit of three phase induction motor from the first principles.

(OR)

b) Discuss the steady state analysis of three phase induction motor. Draw the necessary characteristics.

15. a) Derive the voltage and torque equation of synchronous machine in terms of machine variables.

(OR)

b) Obtain Park's equation for synchronous machine.

PART – C (1×15 = 15 Marks)

16. a) For steady-state balance conditions the total 3-phase real and reactive power may be expressed as

$$P_e = 3V_s I_s \cos[\Theta_{ev}(0) - \Theta_{ei}(0)]$$

$$Q_e = 3V_s I_s \sin[\Theta_{ev}(0) - \Theta_{ei}(0)]$$

Show that the following expressions are equal to those given above :

$$P_e = 1.5\,(V_{qs} I_{qs} + V_{ds} I_{ds})$$

$$Q_e = 1.5\,(V_{qs} I_{ds} - V_{ds} I_{qs})$$

(OR)

b) Draw the mmf pattern of a distributed single phase winding in a three phase machine. Number of slots for a single phase winding can be considered as 6 and number of conductors per slot are two.
