Reg. No. | | | | | | | | | | | | | |

Question Paper Code : X86097

M.E./M.Tech. DEGREE EXAMINATIONS – NOV / DEC 2020

First Semester

Power Electronics and Drives

PX5151 ANALYSIS OF ELECTRICAL MACHINES

(Common to: Power Systems Engineering)

(Regulation 2017)

Time: 3 Hours | Answer ALL Questions | Max. Marks 100

PART- A (10 x 2 = 20 Marks)

1. Draw the B-H curve of a permanent magnet with its load line.
2. In a singly excited electrical machine which inductance takes part in the development of torque? Explain.
3. Why a motor takes longer time to come to standstill if the inertia is increases?
4. If the load torque input to a DC motor is a step change, then state whether the motor line current experiences either a step or exponential change? Justify your statement.
5. State the assumptions made for the transformation of three-phase variables into two phase variables?
6. In which application Park's transformation is used?
7. If the induction motor's variable are represented in synchronous reference frame then what will be the frequency of rotor variables?
8. Write down the torque equation of a three-phase induction machine using only its stator variables.
9. If rotor reference frame transformation is applied on a synchronous machine then what is the frequency of the transformed variables?
10. Draw the free running torque speed characteristics of a synchronous machine.

PART- B (5 x 13 = 65 Marks)

11. a) Show that that in a reluctance motor the developed torque is a function of $\sin 2\delta$, where 'δ' is the rotor position at time $t = 0$ and is known as the load angle or torque angle. (13)

OR

b) The $\lambda - i$ relationship for an electromagnetic system is given by $\lambda = \frac{2.4 i^{1/2}}{g}$ where g is the air gap length. For current $i = 3A$ and $g = 8$ cm, determine the mechanical force on the moving part using the co-energy of the system. (13)

12. a) From first principles determine the voltage and torque equation of dc shunt motor and draw its time domain block diagram. (13)

OR

b) A permanent magnet dc motor has the following parameters: $r_a = 8\Omega$ and $k_v = 0.01\ V$-sec/rad. The shaft load torque is approximated as $T_L = K\omega_r$, where $K = 5\times10^{-6} N - m - sec$. The applied voltage is 6V and $B_m = 0$. Calculate the steady state rotor speed ω_r in rad / sec. (13)

13. a) Apply arbitrary reference frame transformation on a balanced three-phase system with resistive and inductive elements and obtain the expressions and the equivalent circuits in terms of voltage variables V_{qs} and V_{ds}. (13)

OR

b) Using the principle of invariance of power deduce the expression of transformation for converting three-phase *(abc)* variables into two-phase *(dq)* variables, by applying both phase and commutator transformation. (13)

14. a) Compute the starting torque and maximum torque of a three phase, 220V, 4P, 60Hz, 1710 rpm, star connected induction motor whose machine parameters are as follows:

$$R_s = 0.435\Omega\ ;\ X_{Is} = X_{Ir} = 0.754\Omega\ ;\ R'_r = 0.816\Omega\ ;\ X_M = 26.13\Omega\ ;\ J = 0.089\ k$$ (13)

OR

b) Deduce the voltage and torque equations of three-phase induction motor in stator reference frame by applying the theory of transformation. (13)

15. a) A 4-pole, 3-phase, cylindrical rotor synchronous machine is supplied from a 440 V (RMS) line-to-line, 60 Hz source. The machine is operated as a motor with the total input power of 40 kW at the terminals. The machine parameters are $R_s = 0.3\Omega$; $L_{Is} = 0.001\,H$, $L_a = 0.01\,H$, The excitation is adjusted such that I_{as} lags V_{as} by 30^0. Calculate E_a and the reactive power Q. Draw the phasor diagram. (13)

OR

b) Deduce the torque equation of a salient pole synchronous machine with damper windings. (13)

PART- C (1 x 15 = 15 Marks)

16. a) Deduce the dynamic voltage and torque equation of a permanent magnet dc motor and draw the current, torque and speed response characteristics as function of time with respect to (i) starting condition and (ii) sudden change in load condition. (15)

OR

b) Draw the free acceleration characteristics of a three phase induction rotor viewed from rotor reference frame with respect to response variables $V_{qs}^{r}, V_{ds}^{r}, i_{qs}^{r}, i_{ds}^{r}, i'^{r}_{qr}, i'^{r}_{dr}, T_e$ and ω_r. (15)

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