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Question Paper Code : 50977

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fifth/Sixth Semester

Electrical and Electronics Engineering

EE 3009 — SPECIAL ELECTRICAL MACHINES

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Name two types of stepper motors.
2. Write the concept of closed-loop control in stepper motor drives.
3. What are the power controllers used in SRM drives?
4. Write the principle of torque prediction in SRMs.
5. Name two types of permanent magnets used in PMBLDC motors.
6. Write the emf equation of PMBLDC motors.
7. What are the machine configurations of PMSMs?
8. List four general types of rotors in permanent magnet synchronous machines.
9. Name the applications of hysteresis motors.
10. What is hysteresis power loss in hysteresis motor?

PART B — (5 × 13 = 65 marks)

11. (a) Explain the constructional features and operation principle of stepper motors. (13)

Or

- (b) Describe the drive circuits used in stepper motor control and their significance in different applications. (13)

12. (a) Explain the methods for speed and current control in SRM drives. (13)

Or

- (b) Discuss on rotor position measurement and estimation methods of SRM drives. (13)

13. (a) Explain the principle of operation of PMBLDC motors and analyze the magnetic circuit. (13)

Or

- (b) Discuss the current and speed controllers in PMBLDC motor drives. (13)

14. (a) Describe the torque-speed characteristics of PMSMs. (13)

Or

- (b) Describe the operating principle and characteristics of synchronous reluctance motors. (13)

15. (a) Discuss the principle of operation and characteristics of hysteresis. (13)

Or

- (b) Compare and contrast the characteristics of hysteresis motors, AC series motors, and linear motors. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Design a closed-loop control system for a stepper motor-driven robotic arm, considering torque predictions. (15)

Or

- (b) A three phase, Y-connected, $2p = 6$ pole, PM brushless motor has the surface PM of inner radius $R_{in} = 0.06\text{m}$, outer radius $R_{out} = 0.11\text{m}$ and the pole shoe width-to-pole pitch ratio $\alpha = 0.84$, the number of turns per phase $N_t = 222$, the winding factor $k_{wt} = 0.926$ and the peak value of the air gap magnetic flux density $B_{mg} = 0.65\text{T}$. Neglecting the armature reaction, find approximate values of the EMF, electromagnetic torque developed by the motor and electromagnetic power at 1200 rpm and rms current $I_a = 13.6\text{A}$ for 120° square wave operation. (15)