CBCS SCHEME

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17EE554

Fifth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Special Electrical Machines

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. With a neat sketch, explain the construction of a 4 pole, two-phase, 15 rotor teeth hybrid stepper motor. With the help of switching circuit and excitation sequence, explain its working in one-phase ON mode and half-step mode. **(10 Marks)**

b. Explain with a neat block diagram the closed-loop control of a stepper motor. **(06 Marks)**

c. A stepper motor is wound for two phases and has 4 poles. It has 10 rotor poles. Find its revolution. **(04 Marks)**

OR

2 a. Derive the torque equation of a stepper motor. **(08 Marks)**

b. Define the following: i) Step angle ii) Resolution iii) Stepping rate iv) Stepping error. **(08 Marks)**

c. A permanent magnet stepper motor is driven by a series of pulses of duration 20ms. It has 4 stator poles and 6 rotor poles. How long will it take for the motor to make a complete revolution? **(04 Marks)**

Module-2

3 a. List the four constraints on pole arc and tooth arc of switched reluctance motor. Draw L-θ diagram for 8/6 SRM assuming pole arc of 21° and 24° for the stator and rotor respectively. **(10 Marks)**

b. With a neat circuit diagram and current and torque waveforms, explain the following types of BLDC motors i) One-phase and one-pulse and ii) One-phase and two-plane. **(06 Marks)**

c. A 4-phase SRM has 6 rotor teeth. Find the step angle and commutation frequency for a speed of 6000rpm. Given the number of stator poles, $N_s = 8$. **(04 Marks)**

OR

4 a. With a neat sketch, explain the current regulators used for SRM. **(08 Marks)**

b. Compare BLDC motor and conventional DC motor. **(04 Marks)**

c. A permanent magnet DC motor has an armature resistance of 1.03Ω. It draws a current of 1.25A at no load with 50V supply and running at 2100rpm. Find: i) Speed-voltage constant ii) Rotational losses iii) Output power when it runs at 1700 rpm at 48V supply. **(08 Marks)**

Module-3

5 a. Derive the emf equation of permanent magnet synchronous motor. **(10 Marks)**

b. A 3-phase, 4 pole, 50Hz, 400V, star connected synchronous reluctance motor has direct axis and quadrature axis synchronous reactances of 8Ω and 2Ω respectively. For a load torque of 80N-m, find: i) Torque angle ii) Line current and iii) Power factor. Neglect armature resistance and mechanical losses. Given synchronous speed $w_s = 50\pi$ rad/s. **(10 Marks)**

OR

6 a. With a neat diagram, explain the DSP-based control of PMSM. **(07 Marks)**

b. List any seven applications of synchronous reluctance motor. **(07 Marks)**

c. A 3-phase, 4 pole, star connected PMSM has 72 slots with 20 conductors/slot. The flux/pole is 0.05 Wb and the speed is 1500rpm. Assuming full pitched coil, find the phase and line voltage. Given distribution factor $K_d = 0.986$. Assume $K_s = 1$. **(06 Marks)**

Module-4

7 a. Derive the EMF equation of AC series motor. **(10 Marks)**

b. List the applications of universal motors. **(04 Marks)**

c. With a neat sketch, explain the constructional details of a drag cup AC servo motor. **(06 Marks)**

OR

8 a. Derive the voltage equation of a DC servo motor and draw the equivalent circuit. Plot the torque vs current and speed vs current characteristics of DC series motor and DC shunt motor. **(10 Marks)**

b. Explain with circuit diagrams the following speed control methods of universal motor: i) Resistance method and ii) Auto-transformer method. **(06 Marks)**

c. List any four applications of single-phase reluctance motors. **(04 Marks)**

Module-5

9 a. Draw the phasor diagram of a Permanent Magnet Axial Flow motor (PMAF). Neglecting armature resistance and losses, derive the equation of the power developed in PMAF motor. **(10 Marks)**

b. With neat sketches, explain the construction of i) Homopolar DC linear motor and ii) Iron-cored DC linear motor. **(06 Marks)**

c. A vehicle is propelled by a linear induction motor. The motor has 100 poles with a pole pitch of 0.5m. Find the vehicle speed in kmph when the vehicle is running with a slip of 0.25 at a frequency of 50Hz. **(04 Marks)**

OR

10 a. With neat sketches, explain the construction of i) Single-sided PMAF machine and ii) Double-sided PMAF machine with internal PM rotor. **(08 Marks)**

b. Compare slotless and slotted linear synchronous motors. **(04 Marks)**

c. The thrust developed by a 3-phase linear induction motor is 100kN when running at 200Kmph. The supply frequency is 60Hz and the pole pitch is 0.5m. Determine the secondary copper los. **(08 Marks)**

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