(44)

# B.E. DEGREE EXAMINATION APRIL/MAY 2011
## VII SEMESTER
## EE504 SPECIAL ELECTRICAL MACHINES

**Time:3 Hours** Marks:100

(Answer all questions)

PART A (10 X 2 =20 MARKS)

1. Differentiate between detent torque and holding torque of stepper motor
2. Explain half stepping mode of stepper motor..
3. Explain the terms aligned and unaligned inductance in SRM and how these inductances affect the torque production.
4. Explain the operation of hall sensor used for rotor position sensing.
5. What are the advantages of switched reluctance motor over brushless dc motor?
6. Explain the significance of recoil permeability.
7. Explain how constant hp mode of operation is possible in PMSM.
8. Sketch the flux density waveform of 2 pole PMSM with $\alpha$ angle between d axis of the rotor and stator axis.
9. What are the advantages of axial flux machines over radial flux machines?
10. Differentiate between hard and soft magnet.

PART B (5 X 16 = 20 MARKS)

11. Explain the principle of operation of synchronous reluctance machine and derive the torque equation for synchronous reluctance machine.

12.a. Explain the principle of operation of brushless dc motor with
(i)180 arc magnet and 120 degree mode of conduction
(ii) 120 arc magnet and 180 degree mode of conduction

(OR)

12.b. A PM brushless d.c motor has a torque constant of 0.12 Nm/A referred to the d.c supply. Estimate its noload speed in rpm when connected to a 48 V dc supply.

ii) If the armature resistance is 0.15 ohm/hase and the total voltage drop in the controller transistors is 2 V determine the stall current and the stall torque.

iii) The dc current is 8.2 A when the motor is delivering 330 W of mechanical power to a load of at 3400 rpm. The motor is star connected and has two phases on at any instant with a total of 2 V dropped across the conducting transistors in series ,this voltage drop can be assumed to be constant. The friction torque has been separately measured as 0.046 Nm at this speed. If the supply voltage is 48 V d.c calculate the efficiency of the complete drive and the separate power loss components due to a) voltage drop in the transistors b)winding resistance c)friction loss and d ) iron loss .If the iron loss is modeled by means of resistor connected in parallel with each phase of the motor determine the value of this resistance.

13.a. Derive the torque equation for p polepair PMSM with practical 3 phase winding on the stator using Faraday's law

(OR)

13.b Expalin the speed torque characteristics of PMSM with circle diagram of sinewave PMSM showing the current limit and voltage limit loci. Derive an expression for the ratio maximum speed to rated speed in terms of converter voltage and open circuit voltage at the corner point.

14a. A switched reluctance motor with six stator poles and 4 rotor poles has a stator pole arc of 30 and rotor pole arc of 32. The aligned inductance is 10.7 mH and the unaligned inductance is 1.5 mH . Saturation can be neglected . Calculate the instantaneous torque when the rotor is

i) 30 before the aligned position ii ) 25 before the aligned position

The phase current is 7 A. For both cases calculate what is the maximum energy conversion in one stroke if the current is limited to 7 A. Determine the average torque corresponding to the energy conversion.

(OR)

14.b Derive an expression for mechanical power developed in switched reluctance motor.Show that the power conversion effectiveness is less than 50 %. With i-$\lambda$ curves prove that the effectiveness can approach 100 % with extreme saturation.

15.a. Explain with neat diagram the operation of i)variable reluctance and ii)hybrid stepper motors

(OR)

15.b.i)Explain the dynamic characteristics of stepper motors. Explain the stepping mode and slewing mode (7)

ii)Why do you need current suppression circuit? Explain the different current suppression circuits used in stepper motor converter circuits. (9)