Ex/BESUS/ EE- 601/06

B.E. (EE) Part-Ill 6th Semester Examination, 2006

Electrical Machines-III

(EE-601)

Time : 3 hours　　　　　　　　　　　　　　　　　　　Full Marks : 100

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
Two marks are reserved for neatness in each half.

FIRST HALF

1. a) Justify the presence of large tooth in a cylindrical rotor alternator.

   b) Turbogenerators are characterised by large L/D ratio - Explain.

   c) Compare main constructional features of salient pole and nonsalient pole synchronous machines.

   d) Give a neat sketch of brushless excitation system used in large alternator and label its different parts.

(4+4+4+4
)

2. a) Explain why a three phase synchronous motor can run at synchronous speed while a three phase induction motor can not?

   b) A3 phase alternator is running at synchronous speed. Its field is now energised from an ac source at rated frequency. Discuss the magnitude and frequency of generated voltage. Comment on losses.

   c) Show that short circuit characteristics of an alternator is a straight line passing through the origin. Draw curve to show how this characteristic depend on speed.

   d) A cylindrical rotor alternator on load draws a current at a leading pf angle 9 with an internal phase displacement angle *F. Under this condition, find out the electrical angle between field axis and armature reaction axis.

[4+4+(4+2)+2J

3. a) A 3 ph alternator connected to infinite bus is operating at unity power factor at half full load. With field current remaining constant, steam input is increased till alternator begins to operate at full load. Discuss, with the help

of phasor diagram the change in power factor and reactive power, if any.

b) How will you step a synchronous motor while running on load. Give reasons in support of your answer.

c) Draw the complete steady state characteristics of an isolated 3 phase alternator supplying load at (i) 0.9 pf lag, (ii) zero pf lag. Comment on the shape of the above characteristic with justification. Assume the field current to remain constant at a value such that rated terminal voltage appears on no load.

[4+4+(2+6)]

4. a) Draw curve to show how synchronous impedance varies with excitation. How does its value affect alternator performance.

b) Describe mmf method of computation of voltage regulation of alternator. Why is it called optimistic method?

c) The OC characteristics of a 3 phase, 50 Hz synchronous machine is as follows

Excitation current (A)	20	40	60	84	105
Terminal voltage (V)	850	1700	2460	3000	3300

Determine the excitation necessary for full load operation at 0.9 pf leading on 3000V supply. When short-circuited and drivefTaT"normal speed, an excitation of 50 A gives normal full load stator current. The resistance drop is 2% and the leakage reactance drop is 15%. (4+4+8)

5. a) Draw the Reactive power vs load angle of a synchronous machine for (i) $E_o > E_t$, (ii) $E_o = E_t$, (iii) $E_o < E_t$, the symbols having usual significance. Indicate on it leading and lagging pf operating zone.

b) Show that for a cylindrical rotor synchronous motor the difference between active power input and electromagnetic power developed is equal to I^2r loss in armature.

c) A 415 V, 2 pole, 3 phase, 50 Hz star connected nonsalient pole synchronous motor has synchronous reactance of 2 ohm per phase and negligible stator resistance. At a particular field excitation, it draws 20 A at unity power factor from a 415 V, 3 phase, 50 Hz supply. The mechanical load on the motor is now increased till the stator current is equal to 50 A. The field excitation remains unchanged.

Determine (i) per phase open circuit voltage E_o, (ii) the developed power in new operating condition and power factor. [4+5+(5+2)]

SECOND HALF

6. a) Describe the principle of Plugging method for braking of three phase induction motor.

b) A three-phase star connected squirrel cage induction motor initially running on full load at a speed of 1440 r.p.m. on 400 V, 50 Hz is subjected to d.c. dynamic braking. Deduce an expression for braking torque developed in this case.

c) If the motor operating under full load condition with a torque of 4Nw-m is subjected to braking with a direct current of 17.72 amps supplied between any two of its terminals, determine the total braking torque at the instant of switching neglecting stator impedance drops, rotational losses and inertia. The motor how standstill rotor impedance of (0.1 +j0.2)ohm per phase in stator terms and the magnetising reactance of 15 ohms. For the above connection,

lac = Vf Idc (4+4+8)

7. a) Describe the reduced voltage starting of a squirrel cage induction motor by means of an auto-transformer and a star-delta starter and mention their merits and demerits.

b) Design the six sections for a seven stud rotor starter for a 3-phase wound rotor induction motor. The slip at full load current is 2 percent and the maximum starting current is 1.5 times full-load current. The resistance of the rotor is 0.02 ohm per phase. Deduce the formula used for calculating the resistance sections and state the assumptions made. (7+4+5)

8. a) Explain the phenomena of crawling of induction motors.

b) Discuss the principle of pole amplitude modulation method of speed control of a squirrel cage motor.

c) A 50 Hz, 3-phase induction motor has a rated voltage V]. The motors's breakdown torque at rated voltage and frequency occurs at a slip of 0.2. The motor is instead run from a 60 Hz supply of voltage V_2. The stator impedance can be neglected.

i) If V_2 = V,, find the ratio of currents and torques at starting. Also find the ratio of maximum torques.

ii) Find the ratio V_2/V! such that the motor has the same values of starting current and torque at 50 and 60 Hz. (5+5+6)

9. a) What are interpoles? Why are the interpoles designed to provide mmf more than the armature mmf in the commutating zone?

b) What are the problems of regenerative braking and counter current braking of dc series motor? How dynamic braking can be achieved in dc series motor?

c) A single-turn armature coil in the commutating zone has an inductance of 0.025 H. Find what commutating field is required for straight line commutation of 25 Amps. (5+6+5)

10. a) Explain, in detail, the commutation process in a d.c. machine and describe the following terms with reference to commutation of a dc machine, i) Accelerated commutation ii) Linear commutation iii) Retarded commutation

b) The magnetisation curve of a series crane motor running at 600 rpm is a straight line given by $E = 4.9 I_a + 196$, between la = 30 Amp to la - 60 Amp. Calculate the braking resistance to be connected across the motor when the supply is cut-off and dynamic braking is employed to limit the speed to 540 rpm if the descending load exerts a constant torque of 260Nw-m. Total motor resistance is 1.2 ohm. (4½+4½+7)