B.E. (EE) Part-III 6th Semester Examination, 2007

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. Answer any four : [4×4]

   a) Why a 3 phase Synchronous Motor can run at synchronous speed only while a 3 phase Induction Motor can not.

   b) Give important points in favour of rotating field, stationery armature configuration of large alternator.

   c) A 3 phase alternator is synchronised to an infinite bus bar. Explain with the help of phasor diagram. What will happen to the terminal voltage of the alternator when the field current is increased.

   d) Explain what will happen if the load on a 3 phase synchronous motor exceeds the pullout torque.

   e) The use of synchronous condenser improves the system power factor – Explain.

2. a) A 3 phase synchronous motor on load draws a current at leading power factor angle ϕ. If the internal phase displacement angle in the timephasor diagram is ψ, find the angle by which airgap excitation mmf lags the armature mmf.

   b) A 3 phase alternator has an efficiency of 90% when operating at unity power factor and at rated kVA. Explian what happens to its efficiency at rated kVA but at 0.8 pf lagging.

   c) A 3 phase alternator with its armature resistance and the leakage reactance being neglected is synchronised to an infinite bus and its field excitation is kept constant thereafter. Now the machine is loaded by supplying mechanical input to the shaft so that load angle reaches a value of 60°. Find the operating power factor under this condition.

d) Outline the different tasks that the excitation system of large alternators has to perform. With the help of schematic diagram explain how the automatic voltage regulation of an alternator can be realised. [3+3+3+(3+4)]

3. a) What functions are performed by damper in Synchronous motor. Why it is not a necessity in cylindrical rotor machines whereas it is a must for salient pole type?

b) What do you mean by field compounding characteristic of an alternator. Draw this characteristic for (i) zero pf lag, (ii) zero pf lead operation of alternators and justify. Assume that the field current is adjusted so that rated terminal voltage appears on no load in both the cases.

c) Compare the performance of an alternator connected to infinite bus with that of an isolated alternator supplying its own load. [(2+2)+(2+2+2)+6]

4. a) Define short circuit ratio of an alternator. Explain the influence of short circuit ratio on the operating characteristic of alternator.

b) Explain the difference between Potier reactance and armature leakage reactance of a synchronous machine.

c) Why MMF method of computation of voltage regulation is called optimistic method of computation?

A 3 phase, star connected, 1000 kVA, 2000 V, 50 Hz alternator gave the following open circuit and short circuit readings

Field current (A)	10	20	25	30	40	50
OC Voltage (L-L) (V)	800	1500	1760	2000	2350	2600
SC armature current (A)	–	200	250	300		

The armature effective resistance is 0.2 ohm. Determine full load percentage regulation at 0.8 pf lagging using MMF method. [(1+4)+3+(2+6)]

5. a) Draw the phasor diagram of a three phase alternator when it delivers maximum active power output. Neglect armature resistance.

b) A cylindrical rotor synchronous motor is running with constant field current at a lagging pf. Armature circuit resistance is negligible. Discuss what will happen to the magnitudes of load angle, armature current and power factor if frequency is reduced by 10%, both applied voltage and load power remaining constant.

c) A star connected 3 phase alternator is synchronised with an infinite bus of 11 kV; its steam input is then increased till its output power is 15 MW. Now when its excitation emf is increased to 130%, the synchronous machine starts operating at a pf of 0.8 lagging. Compute the synchronous reactance of the machine. Neglect armature resistance.

Determine the load angle, armature current and power factor of the machine before the excitation emf is increased. **[4+(1+1+1)+(6+1+1+1)]**

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 4 Nw-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 has standstill rotor impedance of (0.1 + j 0.2) ohm per phase in stator terms and the magnetising reactance of 15 ohms. For the above connection

$$I_{ac} = \sqrt{\frac{2}{3}}\, I_{dc}$$ **[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 its merits and demerits.

b) A 200 kW, 3300 V, 6 pole, 50 Hz star-connected slip-ring induction motor has a star connected rotor. Stator to rotor turns ration is 3.2. Rotor resistance and leakage reactance are 0.1 Ω and 1 Ω respectively. Neglect stator impedance. Find current and torque at starting on rated voltage and with slip rings short circuited.

c) Explain the phenomena of crawling of induction motors. **[7+4+5]**

8. a) Design the six sections of 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 rotor is 0.02 ohm per phase. Deduce the formula used for calculating the resistance sections and state the assumptions made.

   b) Name the different methods of controlling speed of a polyphase induction motor applicable for both wound rotor and squirrel cage type of induction motors. Discuss the principle of pole amplitude modulation method of speed control of a squirrel cage motor. **[(4+4)+(4+4)]**

9. a) Explain with necessary diagrams the effect of armature reaction on the performance of a d.c. machine.

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

   c) A compensated d.c. machine has 15,000 armature ampere turns per pole. The ratio of pole arc to pole pitch is 0.68. Interpolar airgap length and flux density are respectively 1 cm and 0.25 Tesla. For rated armature current of 850 A, calculate the compensating winding conductors per pole and the number of turns on each interpole. **[5+5+6]**

10. a) Explain various electrical braking methods available for dc motors.

    b) How dynamic braking can be achieved in d.c. series motor.

    c) For a d.c. shunt motor the emf induced at 700 rpm is 220 V. Assuming (i) negligible motor losses, (ii) a friction loss equivalent to a constant frictional torque of 13 Nw-m, find the time taken to fall in speed from 700 r.p.m. to 300 r.p.m. when the armature is disconnected from supply and connected across a resistance of 8.0 ohm keeping the excitation constant. The moment of inertia of the armature is 25 kgm^2. **[7+3+6]**

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