Third Semester Examination – 2006

ELECTRICAL MACHINES

Full Marks : 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** questions from the rest.*

The figures in the right-hand margin indicate marks for the questions.

1. Answer the following questions : 2×10

   (a) What are the two functions of the commutator in d.c. machines ?

   (b) What are the two effects of armature reaction in a d.c. generator ?

(c) What type of d.c. generator is suitable for arc welding and why ?

(d) Explain how the core loss in a transformer is represented in its equivalent circuit.

(e) A two winding single-phase transformer of 400 V/100 V, 50 KVA rating is re-connected as an auto-transformer to get a 400 V supply from a 500 V supply source. Show the connection diagram of the auto-transformer.

(f) Explain why an induction motor, at no-load, operates at a very low power factor.

(g) What is the 'slip frequency' of a 3-phase induction motor operating from a 50 Hz source with a full-load speed of 960 RPM ? What is the 'slip speed' in this case ?

(h) Compute the winding factor of a 3-phase balanced distributed winding with following data : Slots/pole = 9, No. of poles = 2, Coil span = 8 slots.

(i) Draw the V-curves and inverted V-curves of a synchronous motor at half-load and at full-load.

(j) How much starting torque is developed in case of a single phase induction motor ? Explain the necessity of putting a capacitor in series with the starting winding of the single-phase induction motor.

2. (a) Describe the field-flux control method for the speed control of a d.c. shunt motor. What are the merits and de-merits of this method ? 5

(b) A d.c. shunt motor with an armature resistance 5 Ω drives a load at 1250

RPM, drawing an armature current of 120A from a 400 V supply. If the excitation is reduced to 75% of its initial value and the total torque developed by the armature remains unaltered, calculate the new speed of the motor. Neglect saturation effect. 5

3. (a) What are the factors influencing the voltage build-up process in case of a d.c. shunt generator ? Explain in detail. 5

(b) A separately excited d.c. generator has armature circuit resistance of 0.12 ohm and a total drop at brushes is 2 V. When running at 1500 RPM, it delivers a current of 100 A at 300 V to a load of constant resistance. If the generator speed is reduced to 750 RPM, with the field current unaltered, find the current delivered to the load. 5

4. (a) Draw and explain the full-load phasor diagram of a single-phase two-winding transformer supplying full-load at a lagging power factor of 0.8. Discuss how the primary leakage flux is accounted for in the phasor diagram. 5

(b) A 220 V/110 V, single phase two-winding transformer of 10 KVA rating is connected as an auto-transformer across a 55 V supply. What is the maximum output voltage that can be obtained from this auto-transformer ? For a load current of 10 A, determine the KVA output and the currents in the various parts of the auto-transformer. Draw neatly the connection diagram of the auto-transformer and show the currents. 5

5. (a) Explain the following terms in case of a 3-phase induction motor.

(i) Airgap Power P_g

(ii) Internal Mechanical Power developed P_m

(iii) Shaft Power P_{sh}.

Show that the rotor copper loss is 'slip' (s) times the airgap power P_g. 5

(b) A 3-phase, 415 V, 50 Hz induction motor takes a power input of 39 kW at its full-load speed of 930 RPM. The total stator losses are 1200 watts and friction and windage losses are 1450 watts. Calculate the (i) slip (ii) rotor copper losses (iii) shaft power (iv) shaft torque (v) efficiency of the induction motor. 5

6. (a) What do you mean by voltage regulation of a 3-phase alternator ? Find the voltage regulation of an alternator having

synchronous impedance of (0.15+j3) ohms per phase. The terminal voltage (line-line) of the star connected alternator is 11 kV and it is supplying a full-load line current of 50 A at 0.8 power factor lagging to a 3-phase balanced load. What is the load angle of the alternator ? 6

(b) Explain the following terms in case of a 3-phase alternator. 4

(i) three phase balanced distributed winding

(ii) Pitch factor

(iii) distribution factor

(iv) synchronous reactance.

7. (a) How does the input current to the stator of a 3-phase synchronous motor change with variation in field excitation ? Explain with the help of a phasor diagram. 5

(b) A 3-phase, 3.3 kV, 50 Hz, delta connected synchronous motor has a synchronous impedance of 3+j16 ohms per phase. It operates at a power factor of 0.707 loading while drawing a current of 50 A from the mains. Compute its excitation emf and load angle. 5

8. (a) Explain how starting torque is produced in a single phase induction motor with the help of an auxilliary winding. 4

(b) Show the connection diagram of a 3-phase transformer connected in star (wye) delta. 3

(c) Write a short note on 'Stepper motor'. 3