Total number of printed pages - 5e

B. Tech

CPEE 5301

Fifth Semester Examination – 2009

ELECTRICAL MACHINE – I

Full Marks – 70

Time – 3 Hours

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

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) A d.c. shunt motor draws an armature current of 12 A from a 220 V d.c. supply while developing a gross torque of 20 Nm in the armature running at 1200 RPM. What will be the induced back emf in the armature ?

(b) What will be the frequency of induced emf in the conductors of the armature winding of a 8-pole d.c. generator running at 750 RPM ?

(c) Mention with reason the type of d.c. motor used for traction loads.

(d) What is the disadvantage of a 3-point starter as compared to a 4-point starter used to start d.c. shunt motors ?

(e) Explain in brief why the compensating windings in d.c. machines are connected in series with armature.

(f) What is 'voltage regulation' in case of a transformer ? For which type of load power factor will this regulation be zero ?

(g) The iron losses in a 100-kVA transformer are 1000 W. The full load copper losses are 1.25 times the iron losses. Determine the load in kVA to obtain maximum efficiency of the transformer.

(h) Explain why the cross section of the limbs in a core type transformer are stepped instead of being circular.

(i) Draw the per phase phasor diagram of a cylindrical rotor synchronous generator supplying unity power factor load. Show the mmf space phasors in the same diagram.

(j) Calculate the 'winding factor' of a 3-phase balanced winding having a coil span of 9 slots with 54 stator slots and 6 poles.

2. (a) A 220 V d.c. shunt motor has an armature resistance of 0.4 ohm and field resistance of 220 ohms. The no-load input line current of the motor from the 220 V d.c mains is 4.5 A while the no-load speed of the motor is 1500 RPM. The motor takes 22 A from the same 220 V d.c mains while driving the full load torque at 1470 RPM. Find the induced back emf at no-

load and at full-load. What will be the ratio of the full-load torque to the no-load torque developed by the machine? 2+2

(b) Explain briefly the 'commutation process' in a d.c. machine. Describe how the 'interpoles' and the 'compensating winding' help in achieving better commutation. 3+3

3. (a) Draw the field mmf and armature mmf waveforms over one pole pitch in case of a d.c. generator. Show therein the resultant waveform of these two mmfs. Explain 'cross-magnetisation' and 'de-magnetisation' effects of armature reaction. 2+1+2

(b) A 230 V d.c. shunt generator has armature circuit resistance (including brushes) of 0.4 ohm and field circuit resistance of 120 ohms. If this machine is run as a motor by connecting it to a 230 V d.c. mains, find the ratio of speed as a generator to the speed as a motor. The line current in each case is 45 A. 5

4. (a) 'Brake Test' was performed in a d.c. shunt motor and the following readings were obtained. The load on one side of the brake band was 40 kg and on the other side, it was 5.5 kg. The motor was taking a current of 60 A from 400 V d.c. mains while running at 1470 RPM. The pulley diameter is 110 cm. Neglect the belt thickness and determine the torque, output and the efficiency of the motor. 5

(b) Derive the expression for the torque developed in a d.c. motor. Draw and explain the speed-torque characteristic separately in case of shunt and series motors. 5

5. (a) The maximum efficiency of a 150 kVA, 2200/220 V, 50 Hz, single phase transformer is 98.5% and occurs at half-full load at unity power factor. Determine its full-load efficiency at 0.8 leading power factor. 4

(b) The primary of a single phase two winding transformer is rated at 12 A and 1200 V. On open-circuit, the readings (referred to HV side) are V_1=1200 V, V_2 = 600 V, I_0 = 0.52 A, P_0 =150 W. On short-circuit, the readings (on HV side) are I_{sc} = 12 A, V_{sc} = 144 V and P_{sc} = 450 W. Draw an equivalent circuit for the transformer and determine the parameters. What will be the output voltage across a load impedance of 20 + j 15 ohms ? 4+2

6. (a) Develop step by step the exact equivalent circuit of a single phase two winding transformer. 4

(b) A single-phase autotransformer is to deliver a power of 350 kW at unity power factor at 350 volts with an input voltage of 230 volts. Determine the kVA rating of each section of the autotransformer winding. 3

(c) What is 'Polarity Test' in case of a single phase two winding transformer ? Explain clearly with the help of the connection diagram. 3

7. (a) Deduce the expressions for output real and reactive powers from the equivalent circuit (per phase) in case of a cylindrical rotor synchronous generator. 5

(b) A 150 kVA, 3300 V, 50 Hz, star connected three phase alternator has an effective stator resistance 0.125 ohms per phase. During 'Open Circuit Test' of the machine, for a field current of 8.5 A, the terminal voltage is measured to be 600 V line-to-line. While performing the 'Short Circuit Test' on the same machine, the short circuit current is 120 A for the same field current of 8.5 A. Find the terminal voltage per phase when rated full load at 0.8 leading power factor is switched off from the generator without changing its excitation and speed. What is the load angle 'delta' in this case ? 5

8. (a) Explain the method of constructing the 'Potier Triangle' from the 'Open Circuit Characteristic', 'Zero Power Factor

Characteristic' and 'Short Circuit Characteristic' of a cylindrical rotor synchronous generator. What is the difference between the 'potier reactance' and the actual 'leakage reactance' of the machine ?

4+1

(b) Calculate the no-load terminal voltage of a 3-phase, 6-pole, star connected alternator running at 1000 RPM having the following data :

Sinusoidal distributed flux per pole = 60 mWb,

Total number of slots on the stator inner periphery = 54,

Number of conductors per slot =10 and Coil span = 8 slots. 5