Total number of printed pages : 8

B. Tech

BENG 1201

Third Semester Examination – 2007

ELECTRICAL MACHINES

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 for the questions.

1. Answer the following questions : 2×10

   (a) What is the purpose of providing interpoles in d.c. machines ? Where are these interpoles located ?

   (b) Draw the main field mmf waveform and armature reaction mmf waveform together

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over one pole pitch of a d.c. machine. What is the space phase angle between the two mmf axes ?

(c) Explain why speeds lower than the rated speed cannot be obtained by 'Field Control' method of speed control of d.c. shunt motors ?

(d) Draw the phasor diagram of a single-phase transformer supplying full load at 0.8 leading power factor.

(e) Define in words the term 'voltage regulation' in case of a 3-phase synchronous generator and write down the expression for it.

(f) Calculate the 'winding factor' of the 3-phase balanced distributed winding of a 3-phase synchronous generator having 72 stator slots, 6 poles and coil span of 11 slots.

(g) Why does a 3-phase synchronous motor has no self-starting torque ? Explain in brief.

(h) Calculate the 'rotor copper loss' of a 4-pole 3-phase induction motor drawing power from a 3-phase, 415 V, 50 Hz source and running at 1460 RPM. The input power to the rotor is 50 kW.

(i) Draw the 'exact equivalent circuit' of a three phase induction motor and name the various parameters in it.

(j) Explain in brief, the reason for providing a 'capacitor' in a single-phase induction motor.

2. (a) A 16 kW, 240 V, 1300 RPM d.c. shunt motor has 4 poles with a lap-connected armature winding with 950 armature

conductors. The armature resistance is 0.22 ohm and the rated armature and shunt field currents are 80 A and 2 A respectively. Calculate – 5

(i) the flux per pole

(ii) the torque developed

(iii) the gross mechanical power developed

(iv) the rotational losses

(v) the efficiency of the motor.

(b) Draw and explain the external characteristics of d.c. shunt, series and compound generators. 5

3. (a) Explain, in brief, the merits and demerits of controlling the speed of a d.c. shunt motor by field flux control method and armature resistance control method. 5

(b) A 4-pole d.c. shunt generator with lap-connected armature has field and armature resistances 100 ohms and 0.2 ohm respectively. The generator supplies 80 numbers of 100 W lamps at 200 volts. Calculate the load current supplied by the generator, the total armature current, the current per parallel path, the generated emf and the developed armature power in the machine. Neglect brush contact drops. 5

4. (a) Derive an expression for the 'voltage regulation' of a single phase transformer in terms of its per unit resistance and per unit leakage reactance for a leading power factor load. 5

(b) The iron and full load copper losses in a 50 kVA single phase transformer are

700 watts and 1000 watts respectively. Compute the efficiency at (i) full load unity power factor and (ii) 75% of full load at 0.707 lagging power factor. What is the kVA load for maximum efficiency ? 5

5. (a) Explain how the equivalent circuit parameters of a single-phase two winding transformer can be determined by performing the open circuit and short circuit tests in the laboratory ? Draw the circuit diagram and explain the procedure with all required precautions. 6

(b) An 11000/2500 V transformer is rated at 150 kVA as a two winding transformer. If the two windings are connected in series to form an auto-transformer, what will be the possible voltage ratios and corresponding kVA outputs ? 4

6. (a) Describe the advantages and disadvantages of using a short-pitched distributed winding in an alternator. Derive the expression for the 'pitch factor' of the short-pitched distributed winding. 5

(b) Find the no-load induced emf per phase and the load angle 'delta' of a 120 MVA, 13.8 kV, 50 Hz, star connected three-phase alternator having a synchronous impedance of (0.15 + j2) ohms per phase. The generator is supplying rated full load at a power factor of 0.9 lagging. 5

7. (a) Explain any two ways of starting a three-phase synchronous motor. 5

(b) A 3 phase, 13.8 kV star connected synchronous motor draws a current of 60 A from the mains. The effective per-phase synchronous impedance of the motor is (1.25 + j20) ohms. Find the per-phase induced emf and load angle 'delta' for a power factor of 0.8 leading. 5

8. (a) An 8-pole, 3-phase, 50 Hz induction motor runs at a speed of 720 RPM with an input power of 40 kW. The stator copper loss at this operating condition is 1500 watts while the rotational losses (= core + friction + windage losses) are 750 watts. Find – 5

(i) rotor copper loss

(ii) gross torque developed

(iii) gross mechanical power developed

(iv) the net torque output

(v) the net mechanical power output.

(b) Explain how changing the supply frequency can change the speed of a three-phase induction motor ? Mention the advantages and the disadvantages associated with this method. 5