*Total number of printed pages –10*

B. Tech

CPEE 5304

## Sixth Semester Examination – 2007

## ELECTRICAL MACHINE – II

**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 three-phase synchronous machine of negligible stator resistance is under floating condition after being synchronized with the infinite bus. Explain, with the help of its phasor diagram, the next operating

P.T.O.

step required to force the machine to act as a synchronous generator and share the grid load.

(b) What will be the winding factor of a three-phase balanced distributed winding having 54 stator slots, 6 poles and a coil span of 8 slots ?

(c) What is 'Reluctance Power' in case of a salient pole three-phase synchronous generator with negligible stator resistance ? Explain by writing its power-angle equation and drawing its power-angle characteristic.

(d) A three-phase cylindrical rotor synchronous motor, fed from an infinite bus, is operating at unity power factor while driving its rated full-load. What will be the nature of its operating power factor if the load on its shaft is reduced to 70% of its



full-load without changing its excitation ? Explain by drawing its phasor diagram. Neglect the stator resistance.

(e) Explain the meaning of phasor group notations 'Yz1' and 'Dy 11' in case of three-phase transformer connections.

(f) What is 'Open delta' connection ? How does this connection affect the transformer rating ?

(g) A three-phase, 50 Hz induction motor having six poles runs at a full-load speed of 960 r.p.m. What will be the speed of rotation of its rotor field with respect to the rotor structure and also with respect the stator field ?

(h) A three-phase induction motor is to be started first using an autotransformer with 80% tapping and next direct on line. What will be ratio of the starting torques?

(i) Why the developed torque in case of a single-phase induction motor is negative at synchronous speed ? Explain by drawing its torque-speed characteristics.

(j) Explain, with the help of its phasor diagram, how a good operating power factor is obtained in case of a fractional horsepower universal type plain series motor by using salient poles and few stator turns.

2. (a) The per-phase direct axis and the quadrature axis synchronous reactances of a three-phase salient pole synchronous generator are 0.9 per unit and 0.6 per unit respectively. The per-phase effective stator resistance of the machine is 0.1 per unit. The generator is synchronized with the grid and is supplying full-load rated current at 0.95 lagging power factor. Under this loading condition



of the machine, compute its load angle 'delta' and the per-unit no-load induced emf per phase. The excitation of the machine is kept constant throughout the above operation. 6

(b) Describe the experimental method of finding out the per-phase direct axis and the quadrature axis synchronous reactances of a three-phase salient pole synchronous machine by performing 'Slip Test'. 4

3. (a) A 415 V, 50 Hz, 3-phase, 37.3 kW, star-connected synchronous motor has a full-load efficiency of 89%. The synchronous impedance of the motor is (0.25+J1.7) ohms per phase. The excitation of the motor is adjusted to give an operating power factor of 0.95 leading. Under this operating power factor and full-load conditions, compute (i) the per-phase induced emf and (ii) the total mechanical power developed by the motor. 5

(b) Explain, with the help of phasor diagram, the effect of varying excitation on armature current and power factor in a synchronous motor. Draw the family of V and inverted V curves for various loads. 5

4. (a) Draw the physical connections and phasor diagrams for the transformer connections (i) Dz6, (ii) Dy1 and (iii) Yz11. 6

(b) Two single-phase furnaces A and B are supplied at 110 V by means of a Scott-connected transformer-combination from a 3.3 kV, 50 Hz three-phase balanced supply system. The voltage of furnace A is leading to that of furnace B. The furnace A consumes a power of 200 kW at 0.8 lagging power factor while the power requirement of the other furnace B is 350 kW at unity power factor. Calculate the line currents drawn from the 3-phase supply. 4



5. (a) Draw the approximate per-phase equivalent circuit of a three-phase induction motor referred to its stator. How does it differ from the exact equivalent circuit ? 2

(b) Explain how cascading the three-phase slip ring induction motor with another induction motor can change its operating speed ? Explain both cumulative cascade and differential cascade. What are the disadvantages of this method ? 4

(c) A balanced three-phase induction motor has an efficiency of 88% when its output is 60 kW. At this load, both the stator and rotor copper losses are equal to the stator core loss while the rotor core loss is neglected. The Mechanical losses are one-fourth of the no-load loss. Calculate the 'slip' of the motor under this operating condition. 4

6. (a) The full-load efficiency and power factor of a 12 kW, 440 V, 3-phase, 50 Hz induction motor are 88% and 0.9 lag respectively. The blocked rotor line current is 40 A at 220 V. Calculate the ratio of starting to full-load current if the motor is provided with a star-delta starter. Neglect the magnetizing current. What is the ratio of starting torque to full-load torque if the full load slip of the motor under above operating condition is 4% ? 5

(b) A 6-stud starter with 5 sections is required for a three-phase slip ring induction motor having a per-phase rotor resistance of 0.05 ohm. The full-load slip of the motor is 2.5% and the starting current must not exceed twice the full-load current. Determine the resistance in each section of the starter. For small values of slips, the rotor equivalent circuit, as referred to stator, may be



assumed resistive. The no-load current of the motor may be neglected during the design of this starter. 5

7. (a) Describe the following starting methods of a single-phase induction motor :

(i) Split-phase starting using capacitance.

(ii) Shaded-pole starting. 4

(b) A test on the main winding of a 1.5 kW, 4-pole, 220 V, 50 Hz single-phase induction motor gave the following results :

***No-load Test :*** Voltmeter reading = 220 V, Ammeter reading = 4 A, Wattmeter reading = 190 W.

***Blocked-Rotor Test*** : Voltmeter reading = 90 V, Ammeter reading = 11 A, Wattmeter reading = 400 W.

The stator resistance is found to be equal to 1.5 ohm. Calculate the parameters of the equivalent circuit model by putting the magnetizing reactance at the input termi-

nals of the model. Also find out the input line current, power factor and efficiency of the motor at a speed of 1440 r.p.m. 6

8. (a) Explain, in brief, the principle of operation of the following motors :

(i) The Repulsion Motor

(ii) The Reluctance Motor. 5

(b) The resistance and the total inductance of a single-phase fractional horse-power series motor are 30 ohms and 0.5 henry respectively. It draws a current of 0.9 ampere and runs at 1750 r.p.m. when connected to a 220 V d.c. supply. Calculate the operating speed and power factor of the motor when it is connected across a 220 V, 50 Hz a.c. supply and loaded to draw the same current of 0.9 A from the a.c. supply. 5