53 (IE 401) LNMC

2014

ELECTRICAL MACHINES

Paper : IE 401

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1. *(a)* Define a transformer. 3

   (b) Why is the transformer core laminated ? 4

   (c) Derive an expression for the *e.m.f.* induced in a transformer winding. Show that *emf* per turn in primary is equal to *emf* per turn in the secondary. 5

(d) A 100 kVA, 2400/240 – V, 50Hz single phase has an exciting current of 0·64A and a core loss of 700 *watts*, when its high voltage side is energised at rated voltage and frequency. Calculate the *two* components of exciting current. 8

2. (a) From the construction point of view, enumerate the common essential features of rotating electrical machines. 8

(b) Define distribution factor and show that its expression for the fundamental frequency component is given by $\sin qr/2 \,/\, 9\sin r/2$. 6

(c) What should be the value of chording angle for eliminating 5th harmonic ? 6

3. (a) Describe the constructional details of commutators of *DC* machine. 6

(b) Develop the circuit model of a *dc* machine. 4

(c) Four terminals of *dc* shunt machine are available, but these are unmarked. How would you identify the field and armature terminals ? 2

(d) A *dc* shunt generator gives an open-circuit voltage of $240V$. When loaded the terminal voltage falls to $220V$. Determine the load current in case armature-circuit and field winding resistance are $0{\cdot}1\Omega$ and 50Ω respectively. Neglect the effect of armature reaction. 8

4. (a) What do you understand by term space-phase angle ? 4

(b) Discuss the nature of armature reaction flux in a salient pole synchronous machine in case armature current lags the excitation *emf* E_f by 90°. 6

(c) A 3-phase, $17{\cdot}32$ *kVA*, $400V$, star-connected alternator is delivering rated load at $400V$ and at *pf* $0{\cdot}8$ lag. Its synchronous impedance is $0{\cdot}2 + j2\Omega$ per phase. Find the load angle at which it is operating. 10

5. (a) What are the differences between squirrel cage induction motor and slip ring induction motor ? 4

(b) Explain why the rotor of 3-phase induction motor can never attain synchronous speed. 4

(c) A 3-phase, 50*Hz* induction motor has a full-load speed of 960 *rpm*. Calculate the 6

(a) number of the poles

(b) slip frequency

(c) speed of the rotor field with respect to rotor structure.

(d) The power input to 3-phase induction motor is $60kW$. The stator losses is $1kW$. Find the total mechanical power developed and the rotor copper loss per phase, if the motor is running with a slip of 3%. 6

6. (a) Draw the equivalent circuit diagram of a single phase induction motor. Explain the diagram. 10

(b) Explain why a single phase induction motor is not self-starting. 5

(c) Draw and explain the no-load phasor diagram of 1-phase transformer. 5

7. *(a)* Write brief notes on : ***(any two)*** 6×2=12

(i) Reluctance Motor

(ii) Hysteresis Motor

(iii) V-curves.

(b) A 25*kVA*, 2000/200*V*, 50*Hz* transformer has maximum efficiency at 80% of full load. Its per unit resistance and impedance are 0·012 and 0·05 respectively. Determine its efficiency and voltage regulation at half of the full-load and at 0·8 *pf* lagging. 8