53 (IE 401) LNMC

2012 C

2013

(May)

ELECTRICAL MACHINES

Paper : IE 401

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer Question **1** and **any four** from the rest.*

1. Explain why : ***(any five)*** 5×4=20

   (i) The shunt field winding of a DC machine consists of large number of turns of thin wire while the series field consists of few turns of thick wire.

   (ii) The rotor of a three phase induction motor rotates in the same direction with the rotating field produced by the stator flux.

(iii) Shunt motors are considered constant speed motors.

(iv) An induction motor cann't be run at Synchronous speed.

(v) The wattmeter reads core losses in the open-circuit test and copper losses in the short-circuit test.

(vi) Transformers are always rated in KVA.

(vii) When exercising speed control of DC motors with field control method, some difficulties may arise with 3-point starter.

2. (a) A short-shunt compound generator supplies a current of $100A$ at $220V$. The resistance of the shunt field winding is 50Ω, of the series field is 0.025Ω and of the armature is 0.05Ω. Iron and friction losses amount to $1kw$. Find (i) the emf generated (ii) the copper losses (iii) B.H.P. of the prime mover (iv) commercial efficiency. 10

(b) A shunt generator delivers full-load current of $200A$ at $240V$. The shunt field resistance is 60Ω and full-load efficiency is 90%. The rotational losses are $800w$. Find (i) armature resistance (ii) current at which maximum efficiency will occur. 10

3. *(a)* A belt-driven $100kw$, shunt generator running at $300rpm$ on $220V$ bus-bars continues to run as a motor when the belt breaks, then taking $10kw$ what will be its speed ? Given armature resistance = 0.025Ω, field resistance = 60Ω and contact drop under each brush = $1V$. Ignore armature reaction. 8

(b) A $500V$, $10h.p.$ shunt motor has a full-load efficiency of 85%. With the same shunt field and armature current, it is desired to reduce the speed by 30% by inserting a resistance in the armature circuit. Calculate the value of the inserted resistance. The resistances of the field and armature are 400Ω and 0.25Ω respectively. 12

4. *(a)* Derive the condition for maximum efficiency of a transformer. 5

(b) What will happen if the primary of a transformer is connected to DC supply ? 3

(c) Why the no-load current of a transformer is very small ? Draw the phasor diagram of a transformer on no-load. 2+2=4

(d) A 600*kvA* single phase transformer when working at unity power factor has an efficiency of 92% of full-load and also at half-full-load. Determine the efficiency when it operates at unity p.f. and 60% of full-load. 8

Or

(a) A 100*kvA*, 6600/330*V*, 50*Hz* Single phase transformer took 10*A* and 436*w* at 100*V* in a Short-Circuit test, the figures referring to the high voltage side. Calculate the voltage to be applied to the high voltage side on full-load at 0.8 p.f. lagging when the secondary load voltage is 330*V*. 12

(b) A 200*kvA*, 2000/440*V*, 50*Hz* Single phase transformer gave the following test results :

OC test : 2000*V*, 1.8*A*, 1.75*kw* ..... On H.V. Side (LV side open-circuited)

SC test : 13*V*, 300*A*, 1*kw* ..... On L.V. side (HV side short-circuited).

Obtain the equivalent circuit as referred to H.V. side. 8

5. (a) What do you mean by slip of a 3-phase induction motor ? Why is the air gap between the rotor and stator of a 3-phase induction motor kept as short as possible ? 1+3=4

(b) The star-connected rotor of a 3-phase induction motor has a resistance and standstill reactance of $0.4\Omega/phase$ and $2.5\Omega/phase$ respectively. The emf induced between slip rings at standstill is $80V$, the stator being connected to normal supply voltage. Find the rotor current and power factor at starting when the rings are *(i)* Short-circuited *(ii)* Joined to a star-connected resistance of $5\Omega/phase$. 8

(c) 'The starting torque of a 3-phase induction motor is very sensitive to changes in the value of supply voltage'. Explain. 3

(d) A 4-pole, $50Hz$, 3-phase induction motor has a rotor resistance of 0.024Ω per phase and stand still reactance of 0.6Ω per phase. Determine the speed at which maximum torque is developed. 5

6. (a) What is the function of rotor in an alternator ? Discuss with a neat diagram. Why alternators are also called synchronous generators ? 3+1=4

(b) A 3-phase, star-connected alternator on open-circuit is required to generate a line voltage of $3600V$ at $50Hz$ when driven at $500rpm$.

The stator has 3 slots per pole per phase and 10 conductors per slots. Calculate *(i)* the no. of poles and *(ii)* useful flux per pole. Assume all the conductors per phase to be connected in series and the coils to be full-pitch. 9

(c) A 1000*kvA*, 2300*V*, 3-phase star-connected alternator has a resistance of 0.309*Ω/phase* and a synchronous reactance of 3.31*Ω/phase*. Calculate the change of line voltage when the rated output of 1000*kvA* at power factor of 0.8 (lag) is switched off. Assume the speed and the exciting current to remain unaltered. 7

7. Write short notes : ***(any four)*** 4×5=20

(a) Split phase motor.

(b) Star-Delta starting of 3-phase induction motor.

(c) Torque-Armature current and Torque-speed characteristics of DC series motors.

(d) Counter EMF in DC motors.

(e) Universal Motors.
