

2012

ELECTRICAL MACHINES-I

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Question)

1. Choose the correct alternatives for any *ten* of the following:
10 x 1 = 10
- i) For a P-pole machine, the relation between electrical and mechanical degrees is given by
- a) $\theta_{elec} = \frac{2}{P}\theta_{mech}$ b) $\theta_{elec} = \frac{4}{P}\theta_{mech}$
c) $\theta_{mech} = \frac{P}{2}\theta_{elec}$ d) $\theta_{elec} = \frac{P}{2}\theta_{mech}$
- ii) For eliminating n^{th} harmonic from the *emf* generated in the phase of a 3-phase alternator, the chording angle should be
- a) $n \times \text{full-pitch}$ b) $\frac{1}{n} \times \text{full-pitch}$
c) $\frac{2}{n} \times \text{full-pitch}$ d) $\frac{3}{n} \times \text{full-pitch}$
- iii) The waveform of armature *mmf* in a *dc* machine is
- a) square b) rectangular
c) triangular d) sinusoidal.

- iv) The developed electromagnetic force and/or torque in electro-mechanical energy conversion system act in a direction tends to
- increase the stored energy at constant flux
 - decrease the stored energy at constant flux
 - decrease the co-energy at constant mmf
 - decrease the stored energy at constant flux
- v) A lap wound dc generator has 400 conductors and 8 poles. The voltage induced per conductor is 2 V. The generator generates a voltage of
- 100 V
 - 200 V
 - 400 V
 - 800 V
- vi) The flux is maximum in which of the following parts of a dc motor?
- Pole core
 - Under the interpole
 - Under leading pole up
 - Under trailing pole up.
- vii) A star-delta starter is equivalent to an auto-transformer starter with a tapping of
- 86.6%
 - 57.73%
 - 75%
 - 70.2%
- viii) Maximum torque in a 3-phase induction motor varies as
- f
 - $\frac{1}{f}$
 - $\frac{1}{f^2}$
 - $\frac{1}{f^3}$

- ix) The core flux in transformer depends mainly on
- supply voltage
 - supply voltage and frequency
 - voltage, frequency and load
 - voltage, load but not frequency
- x) A 1:1 transformer is used as
- isolation transformer
 - current transformer
 - potential transformer
 - pulse transformer
- xi) The secondary of a transformer in star has an output voltage of 400 V. If the secondary is connected in interstar, then the output voltage becomes
- 346.4 volts
 - 400 volts
 - 460 volts
 - 360 volts.
- xii) The utilization factor for transformers in open-delta is
- 0.75
 - 0.667
 - 0.866
 - 0.5

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 x 5 = 15

- What is meant by armature reaction? Mention the effects of armature reaction on the operation of the CD machine. How is the armature reaction minimized? 1+2+2
- Draw the torque-slip characteristics of a 3-phase induction motor. Indicate clearly on it full-load torque, starting torque, maximum torque, stable and unstable zone. Why do these motors run below synchronous speed? 1+2+2

4. What is reluctance torque? Explain whether a dc motor can develop any reluctance torque. 1+4
5. What are the advantages of distributing a winding in rotating electric machine? Show that $k_d = \frac{\sin \frac{q\gamma}{2}}{q \sin \frac{\gamma}{2}}$, where k_d = distribution factor, q = slots per pole per phase, γ = slot pitch in electrical radian. 2+3
6. Name two materials used for transformer core. Why does transformer core require to be laminated? Why oil is used in transformer? What type of oil is it? 1+2+1+1

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 x 15 = 45

7. a) What is voltage build-up of a *dc* shunt generator? What are the necessary conditions of voltage build-up?
- b) Draw the external characteristics of a dc separately excited generator, shunt generator, series generator, cumulative compounded and differentially compounded generator. Use same axes for all the curves.
- c) A dc shunt generator delivers 40 kW to 240 V when running at 450 rpm. The armature and field resistances are 0.03 ohm and 60 ohm respectively. Calculate the speed of the machine running as a shunt motor and taking 40 kW input at 240 V. Allow 1 V drop per brush. (3+3)+3+6
8. a) Define slip of a 3-phase induction motor. Can it be negative?
- b) Draw the equivalent circuit of 3-phase induction motor and phasor diagram when it is operating on load.
- c) The shaft output power of a 3-phase induction motor is 20 kW at 1440 rpm. Total stator i^2r loss is 650 W. Friction and windage losses amount to 1.2% of shaft output power. Determine the rotor and stator input. (1+1)+(3+3)+(3+4)

9. a) Explain the working principle of a 3-phase induction motor.
- b) Show that the ratio of torque T at any slip s of a 3-phase induction motor to its maximum torque T_m can be derived as

$$\frac{T}{T_m} = \frac{2}{\frac{S_m + s}{s} + \frac{s}{S_m}}$$

where S_m is the slip at maximum torque. Make necessary assumptions.

- c) No-load and blocked rotor test of a 415 V, 3-phase, 50 Hz, star connected induction motor gave the following results:

No-load test(line values): 415 v, 3.5 A, 250 W

Blocked rotor test (line value) : 115 V, 13 A, 1660 W

Stator resistance/ph is 1.5 ohm.

Calculate equivalent circuit parameters. 5+5+5

10. a) Why is it necessary to write the phasor group in the name plate of a 3-phase transformer? What is meant by Yd ll. Draw the phasor and connection diagram of Yzl.
- b) State the condition of parallel operation of 3-phase transformers.
- c) A set of Scott connected transformers is supplying two single phase loads at 100 V. Load across teaser secondary is 350 kW at *upf* and the load across main secondary is 250kW at 0.8 of lagging. For 3-phase line to line voltage of 6600V, calculate primary line currents. Neglect magnetizing current and leakage impedance drops. (1+2+3)+3+6
11. Write short notes on any *three* of the following: 3 x 5
- a) Three point started
- b) Three winding transformer
- c) Swinburne's test
- d) Commutation in *dc* machines
- e) Starting of Squirrel cage induction motor.

=====