Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(EE/EEE-New)/SEM-4/EE-401/2012

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 Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   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) $n \times$ full-pitch b) $\frac{1}{n} \times$ full-pitch

   c) $\frac{2}{n} \times$ full-pitch d) $\frac{3}{n} \times$ full-pitch.

iii) The waveform of armature *mmf* in a *dc* machine is

a) square b) rectangular

c) traingular d) sinusoidal.

iv) The developed eletromagnetic force and/or torque in electro-mechanical energy conversion system act in a direction tends to

a) increase the stored energy at constant flux

b) decrease the stored energy at constant flux

c) decrease the co-energy at constant *mmf*

d) 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

a) 100 V b) 200 V

c) 400 V d) 800 V.

vi) The flux is maximum in which of the following parts of a *dc* motor ?

a) Pole core

b) Under the interpole

c) Under leading pole tip

d) Under trailing pole tip.

vii) A star-delta starter is equivalent to an auto-transformer starter with a tapping of

a) 86·6% b) 57·73%

c) 75% d) 70·2%.

viii) Maximum torque in a 3-phase induction motor varies as

a) f b) $\frac{1}{f}$

c) $\frac{1}{f^2}$ d) $\frac{1}{f^3}$.

ix) The core flux in transformer depends mainly on

a) supply voltage

b) supply voltage and frequency

c) voltage, frequency and load

d) voltage, load but not frequency.

x) A 1 : 1 transformer is used as

a) isolation transformer

b) current transfomer

c) potential transformer

d) pulse transformer.

xi) The secondary of a transformer in star has an output voltage of 400V. If this secondary is reconnected in interstar, then the output voltage becomes

a) 346.4 volts b) 400 volts

c) 460 volts d) 360 volts.

xii) The utilization factor for transformers in open-delta is

a) 0·75 b) 0·667

c) 0·866 d) 0·5.

GROUP – B

(Short Answer Type Questions)

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

2. What is meant by armature reaction ? Mention the effects of armature reaction on the operation of the *DC* machine. How is the armature reaction minimised ? 1 + 2 + 2

3. 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 $k_d = \dfrac{\sin \frac{q\gamma}{2}}{q \sin \frac{\gamma}{2}}$, 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 × 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, cumulatively 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 240V. Allow 1V 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 $i^2 r$ 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

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

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

   c) No-load and blocked rotor test of a 415V, 3-phase, 50Hz, 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) : 115V, 13A, 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 pf lagging. For 3-phase line to line voltage of 6600 V, calculate primary line currents. Neglect magnetising current and leakage impedance drops. (1 + 2 + 3) + 3 + 6

11. Write short notes on any *three* of the following : 3 × 5

    a) Three point starter

    b) Three winding transformer

    c) Swinburne's test

    d) Commutation in *dc* machies

    e) Starting of squirel cage induction motor.