Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (CHE-OLD)/SEM-3/EE-314/2011-12

2011
ELECTRICAL MACHINES

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) The current in the armature of a *d.c.* motor at running condition is equal to

   a) $\frac{V}{R_a}$ b) $\frac{E_b}{R_a}$

   c) $\frac{(E_b - V)}{R_a}$ d) $\frac{(V - E_b)}{R_a}$.

   ii) The speed of a *d.c.* motor is proportional to

   a) $\frac{E_b}{\phi}$ b) $E_b \cdot \phi$

   c) $\frac{\phi}{E_b}$ d) $\frac{1}{E_b \cdot \phi}$.

iii) Brushes of machines are made of

a) Copper b) Graphite

c) CRGO steel d) None of these.

iv) The speed of *d.c.* shunt motor increases when resistance is connected in

a) series with armature

b) series with the field

c) parallel with the field

d) none of these.

v) Transformer oil is used in transformer for

a) lubrication only

b) insulation only

c) cooling only

d) both cooling and insulation.

vi) Which type of alternator is used in a hydel power plant ?

a) Salient pole

b) Cylindrical pole

c) None of these.

vii) Which loss in single phase transformer is measured in open circuit test ?

a) Core loss b) Copper loss

c) Mechanical loss d) None of these.

viii) In a *d.c.* series motor torque is proportional to

a) Ia^2 b) Ia

c) V^2 d) V.

ix) Residual magnetism is essential in the field electromagnets for building up of voltage of all types of *d.c.* generator *except*

a) shunt b) series

c) compound d) separately excited.

x) Voltage regulation of a transformer is given by

a) $\frac{E_2 - V_2}{V_2}$ b) $\frac{V_2 - E_2}{V_2}$

c) $\frac{V_2 - E_2}{E_2}$ d) None of these.

xi) Which type of loss is measured in the short circuit test of single phase transformer ?

a) Iron loss

b) Copper loss

c) Bearing friction loss

d) None of these.

xii) For a 3-phase induction motor synchronous speed (N_S), stator frequency (f) and number of poles (P) are related by

a) $N_S = \frac{P}{120\, f}$ b) $f = \frac{PN_S}{120}$

c) $f = 120\frac{N_S}{P}$ d) $N_S = 120\frac{P}{f}$.

GROUP – B

(Short Answer Type Questions)

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

2. Explain the function of a commutator in *d.c.* machine for motoring and generating action.

3. With diagram explain the operation of a 3 point starter to start a *d.c.* motor.

4. Explain why transformer core is made of laminated silicon steel.

5. Name the types of alternators based on their rotor construction and state the application of each type.

6. Explain the purpose of using the following in a transformer :

   i) Conservator

   ii) Breather.

GROUP – C

(Long Answer Type Questions)

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

7. a) For any *d.c.* machine, prove that $E = \frac{ZN\Phi P}{60\ A}$ [all the parameters bear the usual meaning]. 4

b) Why is the speed torque characteristic of *d.c.* shunt motor of drooping nature ? 3

c) A pole, 250 volt, wave connected shunt motor gives 10 kW when running at 1000 r.p.m. and drawing armature and field currents of 60A and 1A respectively. It has 560 conductors. Its armature resistance is 0·2 ohm. Assuming a drop of 1 volt per brush, determine

i) total torque

ii) useful torque

iii) useful flux per pole

iv) rotational losses

v) efficiency. 8

8. a) Why are *d.c.* series motors used in trains ? 4

b) State the conditions when a shunt generator fails to build up. 5

c) A 250 V *d.c.* shunt generator runs at 1400 rpm at no-load taking an input of 800 W. The armature resistance is 0·2 ohm and the shunt field current is 5 A. Find the line current at which maximum efficiency occurs. Also find the value of maximum efficiency. 6

9. a) For a single phase transformer prove that the induced *e.m.f.* can be given by $E_{rms} = 4 \cdot 44\ \Phi_m\ fN$ volts where all the parameters bear the usual meaning. 8

b) How many losses do take place in a transformer ? Why the core of a transformer is made up of the laminated sheet steel ? Write down the expressions of the hysteresis loss and the eddy current loss. 7

10. a) What are leakage reactance and magnetising reactance ? 2 + 2

b) Draw the equivalent circuit of a transformer. 5

c) Draw the phasor diagram referred to primary side of a transformer. 6

11. a) Draw the complete torque-slip characteristics of a 3-phase induction motor and show motoring, generating and breaking regions. Explain each mode of operation. 9

b) A 746 kW, 3-phase, 16-pole induction motor has a rotor impedance of (0·02 + j0·15) Ω at standstill. Full load torque is obtained at 360 r.p.m.

Calculate,

i) the speed at which maximum torque occurs

ii) the ratio of maximum to full load torque. 6