Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/ICE(N)/SEM-5/IC-503/2012-13

2012
ELECTRIC MACHINE

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 × 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) The pitch factor, in rotating electrical machinery, is defined as the ratio of resultant *emf* of a

a) full-pitched coil to that of a chorded coil

b) full-pitched coil to the phase *emf*

c) chorded coil to the phase *emf*

d) chorded coil to that of a full-pitched coil.

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

a) square b) rectangular

c) triangular d) sinusoidal.

iv) In *ac* rotating machines, the generated or speed *emf*

a) is in phase with the working flux ϕ

b) leads ϕ by 90°

c) lags ϕ by 90°

d) lags ϕ by 180°.

v) Absence of odd harmonics in magnetizing current of transformer will make the

a) voltage wave sinusoidal

b) voltage wave non-sinusoidal

c) flux wave sinusoidal

d) flux wave non-sinusoidal.

vi) A three-phase transformer with *h.v.* in delta and *l.v* in star can have the symbols..... .

a) *Y*d11 or *y*d1 b) D*y*1 or D*y*11

c) D*y*0 or D*y*6 d) D*y*1 only.

vii) As far as construction is concerned, the synchronous motor is similar to

a) an alternator

b) a slip ring induction motor

c) a transformer

d) a stepper motor.

viii) For successful parallel operation of two single phase transforms, the most essential condition is

a) equal percentage impedances

b) properly connected polarities

c) equal turns-ratios

d) equal kVA ratings.

ix) If the stator impedance in a three-phase induction motor is neglected, the maximum torque will occur at starting if

a) $r'_2 = 2x'_2$ b) $r'_2 = 2x'_2$

c) $r'_2 = x'_2/2$ d) $r'_2 = \frac{1}{3}x'_2$.

x) The torque developed by a 3-phase induction motor depends on

a) V b) V^2

c) $\sqrt{V}$ d) $1/V$.

xi) *V-V* connection is employed when

a) three-phase load is comparatively small

b) supplying a two-phase load is needed

c) high current is required

d) three-phase load is comparatively large.

xii) It is desirable to eliminate 5th harmonic voltage from the phase voltage of an alternator. The coils should be short pitched by an electrical angle of

a) 30° b) 36°

c) 72° d) 18°.

GROUP – B

(Short Answer Type Questions)

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

2. Show that the *emf* generated in a short-piched coil is reduced by the factor $\cos\frac{\alpha}{2}$, where α is the chording angle.

3. Explain why it is not possible to operate a star/delta transformer in parallel with a star/star or delta/delta transformer.

4. Discuss with necessary diagrams, the nature of armature reaction in an alternator for a 90° lagging load.

5. "A star-delta starter of a 3-phase induction motor is equivalent to an auto-transformer starter with 58% tapping." Explain.

6. In a salient pole synchronous machine, the value of X_d is always greater that that of X_q. Discuss the reasons.

GROUP – C

(Long Answer Type Questions)

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

7. a) Draw the connection diagrams and corresponding phasor diagrams of the following three-phase transformers :

   (i) D*y*11

   (ii) *Dz*0

   (iii) *Y*d1

   (iv) *Yy*6.

   b) Two transformers, connected in open delta, supply a load of 400 kVA at 0·866 lagging power factor.

   Calculate :

   (i) kVA supplied by each transformer

   (ii) kW supplied by each transformer. 8 + 7

8. a) Explain the principle of operation of a polyphase induction motor.

b) Explain the phenomenon of cogging and crawling of a 3-phase squirrel cage induction motor.

c) A three-phase, 4 pole, 440 V, 50 hz, induction motor runs on full load at 4 per cent slip. The stator-to rotor turns ratio is 5 : 4. The resistance of the rotor per phase is 0·1 Ω and its reactance at standstill is 0·8 Ω per phase.

Calculate :

(i) the mechanical power output

(ii) the torque

(iii) the maximum torque,

(iv) the speed at maximum torque

(v) the power output when the torque is maximum.

4 + 5 + 6

9. a) Explain the torque-speed characteristic of a 3-phae induction motor. Using the expression for the torque in terms of slip, show that the maximum torque is independent of rotor resistance.

b) Show that the ratio of torque T at any slip s of 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 block rotor test of a 415 V, three-phase, 50 Hz, star connected induction motor gave the following results :

No load test (line values) : 415 V, 3·5 A, 250 W

Block rotor test (line values) : 115 V, 13 A, 1660 W.

Stator resistance per phase is 1·5 Ω. Calculate equivalent circuit parameters of the motor. 5 + 5 + 5

10. a) What is distribution factor ? Derive the expression for the distribution factor of a synchronous machine.

b) Write the conditions for parallel operation of an alternator with an infinite busbar.

c) A 3-phase star connected alternator is rated 1600 kVA, 13500 V. The effective armature resistance and synchronous reactance are 1·5 Ω and 30 Ω respectively per phase. Calculate the percentage voltage regulation for a load of 1280 kW at a *pf* of 0·8 lagging. 5 + 5 + 5

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

a) Stepper motor

b) Starting of synchronous motor

c) Two-reaction theory

d) Switched reluctance motor

e) Hysteresis motor.