ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2008

ELECTRICAL MACHINE DESIGN

SEMESTER – 6

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) For very high speed, brushes in a d.c. machine are made of

a) metal graphite b) carbon graphite

c) graphite d) electro-graphite. ☐

ii) In D.C. generators, lap winnding is used for

a) high voltage, high current b) low voltage, high current

c) high voltage, low current d) low voltage, low current. ☐

iii) A 12-pole machine will pass through electrical degrees in one revolution of value

a) 60° b) 360°

c) 1080° d) 2160°. ☐

iv) In a synchronous machine, the damper winding is used to

a) reduce air gap flux b) reduce oscillation

c) increase stability limit d) none of these. ☐

v) What is the maximum possible peripheral velocity which the rotor of a turbo generator can tolerate ?

a) 30 m/sec b) 50 m/sec

c) 120 m/sec d) 180 m/sec. ☐

vi) In a d.c. machine, for the same core area, hysteresis loss

a) increases with increase in number of poles

b) decreases with increase in number of poles

c) remains same for any number of poles

d) none of these. ☐

vii) Crawling in an induction motor is caused by

a) high load

b) low voltage

c) fifth harmonic present in the supply voltage

d) none of these. ☐

viii) Multi-step core is used in a transformer to

a) increase output b) decrease the cost of core material

c) increase the efficiency d) none of these. ☐

ix) As volt per turn of transformer increases, the per unit reactance will

a) increase b) not change

c) decrease d) vary randomly. ☐

x) Mica separators in a commutator are undercut to

a) prevent sparking

b) have proper insulation

c) decrease reduction in thickness

d) none of these. ☐

xi) Interpoles are used in d.c. machine to

a) decrease armature reaction

b) to strengthen flux of main poles

c) improve commutation

d) none of these. ☐

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. What are the various types of winding commonly used in transformer ? Justify this selection.

3. Explain cogging and crawling in 3-phase induction motor.

4. a) The main dimensions of a core type three phase distribution transformer are iron area (gross) 417 cm^2 , height of window 45 cm, width of window 15 cm. Determine the approximate kVA rating of the transformer.

   b) Why does the yoke of a transformer have the larger section than the limb ?

   3 + 2

5. Explain why a turbo-alternator has smaller diameter and larger length whereas a water wheel generator has smaller length and larger diameter.

6. Explain the term SCR and its effect on the performance of the synchronous machine.

GROUP – C

(Long Answer Type Questions)

Answer any *three* questions. $3 \times 15 = 45$

7. A 25 kVA 6600/440 V, 50 Hz, 3-phase, delta-star core type transformer has the following data :

   emf per turn = 2·12 V

   Window space factor = 0·3

   Maximum flux density = 1·1 tesla

   Current density = 2·3 A/mm^2

   Window height/window width = 3

   For a cruciform core, find (i) diameter of the circumscribing circle, (ii) width and height of window, (iii) conductor cross-sections for both windows and (iv) turns per phase in both windings. 4 + 4 + 4 + 3

8. a) Why are turbo generators built as non-salient pole machines whereas hydro-generators are built as salient pole machiens ?

b) What are the effects of air gap length on the performance of a synchronous generator connected to an infinite bus ? How is the air gap estimated ?

c) Find the main dimensions of a 2500 kVA, 187·5 r.p.m., 50 Hz, 3-phase, 3 kV and salient pole syynchronous generator. The generattor is to be a vertical, water wheel type. The specific magnetic loading is 0·6 Wb/m^2 and the specific electric loading is 34000 A/m. Use circular poles with ratio of core length to pole pitch = 0·65. Specify the type of pole construction used if the run-away speed is about 2 times the normal speed. 3 + 5 + 7

9. a) With neat sketches, describe the constructional detail of the rotors and rotor windings used in hydro- and turbo-generators.

b) What are the causes of harmonics in the voltage and current waves of a synchronous machine and what means are taken in design to reduce them ?

c) The following are design data for a 3-phase, 25000 kW, 6·6 kV, 50 Hz, 2-pole turbo-alternator, working at 0·8 power factor :

Stator : internal diameter 100 cm, core length 210 cm, number of slots 72, two-layer winding with 2 conductors per slot, coil span 27 teeth, two paths in parallel, star connected. Obtain the loading constants. 5 + 5 + 5

10. a) How does the air gap length of an induction machine effect the power factor, overload capacity and tooth pulsation loss ?

b) A 15 kW, 440 V, 4-pole, 50 Hz, 3 Φ induction motor is built with a stator bore 0·25 m and a core length of 0·16. The specific electric loading is 23000 ampere conductor per metre. Using the data of this machine, determine the core dimension, no. of stator slots and no. of stator conductors for a 11 kW, 460 volt, 6-pole, 50 Hz motor. Assume a full load efficiency of 84% and power factor 0·82 for each machine. The winding factor is 0·955. 7 + 8

11. A 6-pole, 72 slot d.c. armature has 6 coil sides per slot. It is to be provided with a simplex lap winding having 8 equalizer rings. Find the number of commutator segments and the winding pitches for a full pitch coil. Work out the arrangements for equalizer rings. Find whether the winding is symmetrical or not. 7 + 6 + 2

END