ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2007

ELECTRICAL MACHINE DESIGN

SEMESTER – 6

me : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

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

i) For large capacity transformer the core cross-section is

a) multistepped b) square

c) rectangular d) circular. ☐

ii) Which loss in a *dc* machine does not vary with load as well as flux density ?

a) Copper loss b) Eddy current loss

c) Hysteresis loss d) Windage loss. ☐

iii) The air gap of a polyhase induction motor is kept small to

a) reduce the possibility of crawling

b) reduce the noise

c) reduce the magnetizing current

d) obtain high starting torque. ☐

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

a) reduce air gap harmonic flux b) reduce oscillation

c) increase stability limit d) resist moisture. ☐

v) When a synchronous generator is designed with the lower value of SCR, it

a) will give higher stability limit

b) will have lower SC current

c) will give better voltage regulation

d) will have higher synchronizing power.

vi) Which of the following is the least desired property in magnetic material for making electrical machines ?

a) High electrical resistivity b) High magnetic permeability

c) Low loss co-efficient d) Large hysteresis loop.

vii) The leakage reactance of a transformer is

a) directly proportional to number of turns

b) proportional to square of number of turns

c) inversely proportional to number of turns

d) inversely proportional to square of number of turns.

viii) Fractional slot winding is used in

a) single-phase induction motor

b) deep-bar squirrel cage induction motor

c) hydroelectric generator

d) turbo alternator.

ix) When compared with power transformer a distribution transformer has

a) low percentage impedance and high copper to iron loss ratio

b) high percentage impedance and high copper to iron loss ratio

c) high percentage impedance and low copper to iron loss ratio

d) low percentage impedance and low copper to iron loss ratio.

x) Per unit impedance of a transformer can be increased by

a) decreasing the spacing between the *h.v* and *l.v.* windings

b) increasing the axial height of the windings

c) increasing the core flux density

d) increasing the radial thickness of the windings. ☐

xi) For the same voltage and output, the air gap is the least in

a) induction motor b) d.c. machine

c) turbo-generator d) hydroelectric generator. ☐

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

a) metal graphite b) carbon graphite

c) graphite d) electro graphite. ☐

GROUP – B

(Short Answer Type Questions)

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

stinguish between induced ventilation and forced ventilation.

plain the significance of B_{30} in the calculation of the magnetizing current of an uction motor.

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

lain, what are the effects of air gap length on the overload capacity and power or of an induction motor.

sider any type of rotating machine and show for it how its capacity and losses vary its linear dimensions.

GROUP – C

(Long Answer Type Questions)

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

7. a) 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 ? 5

b) With neat sketches, describe the constructional detail of the rotors and rotor windings used in hydro and turbo-generators. 5

c) The following are design data for a 3-phase, 25,000 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

8. a) Discuss the phenomena of cogging and crawling and indicate with reasons how they are taken care of in the design of induction motors. 9

b) Design a suitable stator winding stating the number of stator slots, conductors per slot and coil pitch for a 10 kW, 3-phase, 50 Hz, 380 V Squirrel cage induction motor to run approximately at 3000 rpm. Stator bore diameter core lengths are 12·6 cm and 14 cm respectively. (Assume B_{av} = 0·45 Wb/m ^{2}, $\overline{ac}$ = 250 A/cm, power-factor = 0·85 and efficiency = 0·82) 6

9. a) Assuming sinusoidal distribution of currents in the bars of a squirrel cage induction motor over a pole-pitch, show that the *rms* value of end-ring current is

$$I_e = \frac{S_r \cdot I_b}{\pi p}$$

where, S_r = number of rotor slots, I_b = *rms* value of bar current and p = number of poles.

b) Estimate the stator core dimension, number of stator slots and number of stator conductors per slot for a 100kW, 3.3 kV, 50 Hz, 12-pole star connected slip-ring induction motor. Assume : average gap density = 0·4 Wb/m ^{2}, specific electric loading = 25,000 A/m, efficiency = 0·9, power factor = 0·9 and winding factor = 0·96. 6

Choose the main dimension to give best power factor. The slot loading should not exceed 500 ampere conductor. 9

). a) State and explain different core designs in case of transformer. 5

b) Determine the dimensions of the core, the no. of turns and the cross-section of the conductors for a 5 kVA, 11000/400 V, 50 Hz single phase core type distribution transformer. The net conductor area in the window is 0·6 times the net cross-section of iron in the core. Assume a square cross-section for the core of flux density 1 Wb/m ^{2}, a current density 1.4 A /mm ^{2} and a window space factor 0·2. The height of window is 3 times its width. 10

. a) What are the points to be considered when fixing up the dimension of slots of *dc* machine ? 5

b) What is retarded commutation ? 5

c) Find the suitable size of diameter and length of armature core for a 100 kW, 250 V, 70 rpm 4-pole *dc* generator on the basis of the following data :

Efficiency = 90%

Specific magnetic length = 0.58 Wb/m ^{2}

Specific electric loading = 28×10^3 A/m

Assume frequency range = 25 to 50 Hz, maximum allowable current per brush arm = 200 A and square pole face. 5