ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE - 2009

ELECTRICAL MACHINE DESIGN

SEMESTER - 6

Time : 3 Hours] [Full Marks : 70

GROUP - A

(Multiple Choice Type Questions)

1. Choose the most appropriate alternative for any *ten* of the following : $10 \times 1 = 10$

i) The core section of a large capacity tranformer is

a) cruciform b) rectangular

c) multistepped d) circular. ☐

ii) The air gap of a polyphase induction motor is kept small to

a) reduce possibility of crawling

b) reduce the noise

c) reduce the magnetizing current

d) obtain high starting torque. ☐

iii) Coils used in loading rheostats are made up of

a) Iron-Constantan b) Nichrome

c) Copper d) both (a) & (b). ☐

iv) When a 3-ϕ induction motor is designed with higher value of B_{av}, it will give

a) high full load *pf* b) a higher starting torque

c) higher full load efficiency d) higher overload capacity. ☐

v) The least desired property of a magnetic material for making electrical machines is

a) high electrical receptivity b) high magnetic permeability

c) low loss co-efficient d) large hysteresis loop. ☐

vi) The leakage reactance of a transformer is

a) directly proportional to number of turns

b) directly proportional to square of number of turns

c) inversely proportional to the number of turns

d) inversely proportional to the square of number of turns. ☐

vii) The maximum permissible temperature for class A insulation is

a) 90°C b) 105°C

c) 155°C d) 180°C. ☐

viii) Carter's co-efficient is applied to estimate

a) requirement of air gap *mmf* b) flux distribution in air gap

c) length of air gap d) no load loss. ☐

ix) If a transformer is to be disigned for minimum total cost, the condition is

a) cost of iron must be equal to the cost of conductor

b) weight of iron is equal to the weight of conductor

c) iron loss is equal to the I^2R loss in conductor

d) volume of iron is equal to the volume of conductor. ☐

x) A large value of ampere conductors per metre means

a) greater amount of copper is used in the machine

b) space required for insulation is less

c) less number of turns per phase

d) less temperature rise. ☐

xi) In choke used in series with a discharge lamp, the voltage drop across the choke is

a) inversely proportional to area of core

b) proportional to the average flux density in Wb/m^2

c) inversely proportional to supply frequency

d) inversely proportional to the number of turns in the choke coil. ☐

xii) In case of induction motor, the average value of air gap flux density taken is

a) 1·2 to 1·5 tesla b) 0·7 to 1·0 tesla

c) 0·3 to 0·6 tesla d) 0·1 to 0·2 tesla. ☐

GROUP – B
(Short Answer Type Questions)

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

2. With reference to induction motor, discuss the meaning of the following :
   i) Specific electric loading
   ii) Specific magnetic loading.
3. What are the factors that limit the design of an electric machine ?
4. a) Define specific permeance.
   b) Mention principal components of armature leakage flux.
5. A plunger type magnet has to lift a mess of 150 kg from a distance of 10 mm. The area of pole face is 5×10^{-3} m^2. Find the current required if the excitation coil has 3000 turns. Assume that the *mmf* required for iron parts = 10% of air gap *mmf*. Neglect fringing.
6. A 250 V, 1·5 kW single element electric furnace is to employ a nichrome resistance wire operating at 1000°C. Estimate a suitable diameter of the wire. Take radiating efficiency = 1, emissivity = 0·9 & the resistivity of wire = 0·424 Ωm at 1000°C.

GROUP – C
(Long Answer Type Questions)

Answer any *three* questions. 3 × 15 = 45

7. a) Design an iron cored choke to be connected to 230 volt a.c. supply (50 Hz) & suitable for 5 amp inductive current.
   b) i) What are the types of electromagnets ?
   ii) Which types of materials are used in the core of electromagnets ? 10 + 5
8. Determine the approximate diameter & length of the stator core, the number of stator slots & the number of conductors for a 11 kW, 400 V, 3-phase, 4-pole, 1425 rpm delta connected induction motor. Adopt a specific magnetic loading of 0·45 Wb/m & a specific electric loading of 23,000 A/m. Assume full load efficiency & power factor as 0·85 & 0·88 respectively. The ratio of lore length to pole pitch is 1. The stator employs a double layer winding.

9. a) What are the different methods of cooling of transformers ?

b) Develop the expression for the output kVA '*Q*' of a single phase transformer involving frequency, flux density, current density, core window area and net core area.

c) Calculate the dimensions for core & yoke for a 5 kVA, 50 Hz, single phase core type transformer. A rectangular core is used with long side twice as long as short side. The window height is 3 times the width. Voltage per turn is 1·8 V, space factor 0·2, current density 1·8 A/mm ^{2}, flux density 1 Wb/m ^{2}. 3 + 5 + 7

10. a) Calculate the expression for magnetizing current for the following :

i) Concentrated winding

ii) Distributed winding with sinusoidal flux distribution.

b) Calculate the specific iron loss in a specimen of alloy steel for a maximum flux density of 3·2 Wb/m ^{2} & a frequency of 50 Hz using 0·5 mm thick sheets. The resistivity of alloy steel is 0·3 × 10 $^{-6}$ Ωm. The density is 7·8 × 10 ^{3} kg/m ^{2}. Hysteresis loss in each cycle is 400 J/m ^{3}. 8 + 7

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

a) Modern trends in design of electric machine.

b) Bushing & transformer insulation.

c) Design of capacitors for power system.

d) Core design of 3-phase transformer.

END