C 14725

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Name.................................

Reg. No...............................

SIXTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION DECEMBER 2010

EE 04 605—ELECTRICAL MACHINE DESIGN

(2004 admissions)

me : Three Hours

Maximum : 100 Marks

Answer **all** *questions.*

I. (a) What is meant by specific magnetic loading of a D.C. machine ? Explain the factors affecting the specific magnetic loading.

(b) Briefly explain armature reaction and its effect in a D.C. machine.

(c) What are the different types of core constructions used in transformers ? Also explain how they are chosen.

(d) Explain the thermal rating of a transformer.

(e) What are the major considerations while selecting the length of air gap for a synchronous machine ?

(f) Give a comparison of single turn versus multiturn coils for the stator windings of a synchronous machine.

(g) Explain the phenomenon of crawling in induction machines.

(h) Enumerate the rules for selecting the rotor slots for squirrel cage induction motor.

(8 × 5 = 40 marks)

II. (a) (i) Briefly discuss the factors to be considered for the selection of no. of poles of a D.C. machine.

(5 marks)

(ii) Determine the number of poles, and the length of air gap of a 600 kW, 500 V, 900 r.p.m. D.C. generator. Assume average gap density as 0.6 Wb/m^2 and ampere conductors per metre as 35,000. The ratio of pole arc to pole pitch is 0.75 and the efficiency is 91 %. The m.m.f. required for air gap is 50 % of armature m.m.f. and gap contraction factor is 1.15.

(10 marks)

Or

(b) (i) Explain the design procedure for the shunt field winding for a D.C. machine. (5 marks)

(ii) The following particulars refer to the shunt field coil of a 440 V, 6-pole d.c. generator

M.m.f. per pole = 7000 A ; depth of winding is 50 mm ; length of inner turn = 1.1 m ; length of outer turn = 1.4 m ; loss radiated from outer surface excluding ends = 400 W/m^2 ; space factor = 0.62 ; resistivity = 0.02 Ω/m. Calculate (a) diameter of wire ; (b) length of coil ; (c) number of turns ; and (d) exciting current.

Assume a voltage drop of 20 % of terminal voltage across the field regulator.

(10 marks)

Turn over

III. (a) (i) Obtain the relation between core area and weight of iron and copper for a transformer.

(5 marks)

(ii) Calculate the ratio of weight of iron to weight of copper, net iron area, voltage per turn for a 500 kVA, 50 Hz single phase core type transformer for (i) maximum efficiency to occur at 90 % of full load ; (ii) minimum weight ; (iii) minimum volume. Assume : maximum flux density 1.5 Wb/m^2 ; current density = 2.75 $A/mm.^2$, resistivity of copper at 75° C = 2.1×10^{-2} Ωm ; density of iron = 7.65×10^3 kg/m^2 ; density of copper = 8.9×10^3 kg/m^2 ; ratio of specific cost of copper to specific cost of iron for built up cores = 4 ; ratio of mean length of turn of windings to length of flux path = 0.5 ; stray load loss = 10 % of full-load copper loss ; iron loss per kg for 1.5 Wb/m^2 = 1.23 W. Assume an extra loss for joints = 20 % of total iron loss.

(10 marks)

Or

(b) (i) What are the losses occurring in a transformer ? How these vary with change in frequency ?

(5 marks)

(ii) An 11 kV, 25 Hz transformer has I^2 R, hysteresis and eddy current losses 1.6, 0.6 and 0.4 % of the output. What will be the percentage losses if the transformer is connected to 22 kV, 50 Hz supply assuming the full load current remains the same.

(10 marks)

IV. (a) (i) Derive the output equation for a 3-phase alternator. (5 marks)

(ii) Discuss the various factors governing the choice of specific magnetic and electric loading of a synchronous machine.

(10 marks)

Or

(b) (i) Explain the use of damper windings in synchronous machines. (5 marks)

(ii) A 1250 kVA, 3-phase 6500 V salient pole alternator has the following data :

Air gap diameter = 1.6 m ; length of core = 0.45 m. number of poles = 20 ; armature ampere conductors per metre = 28,000 ; ratio of pole arc to pole pitch = 0.68 ; stator slot pitch = 28 mm ; current density in damper bars = $3A/mm^2$.

Design a suitable damper winding for the machine.

(10 marks)

V. (a) Determine the main dimensions, number of radial ventilating ducts, number of stator slots and the number of turns per phase of a 3.7 kW, 400 V, 3-phase, 4-pole 50 Hz squirrel cage induction motor to be started by a star delta starter. Work out the winding details.

Assume :

Average flux density in the gap = 0.45 Wb/m^2., ampere conductors per metre = 23,000, efficiency = 0.85 and power factor = 0.84. winding factor = 0.955, stacking factor = 0.9.

(15 marks)

Or

(b) A three-phase 440 V, 750 r.p.m., 50 Hz star connected induction motor has a stator with an internal diameter of 0.25 m and an axial length of 0.15 m. It has 48 slots with 24 conductors per slot. Calculate the air gap flux per pole.

The area of stator conductors is to be 5 mm^2. Calculate the width and the depth of the slot to accommodate the stator conductors. The maximum flux density in the teeth is to be 1.7 Wb/m^2. Conductor insulation is 0.08 mm thick and slot insulation is 0.8 mm thick. Make other suitable assumptions.

(15 marks)

[4 × 15 = 60 marks]