USN | | | | | | | | | | | **06EE63**

Sixth Semester B.E. Degree Examination, December 2010

Electrical Machine Design

Time: 3 hrs.   Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Classify the insulating materials used in the electrical machines based on thermal considerations. **(08 Marks)**

b. Find the main dimensions, number of poles and length of airgap of a 1000 kW, 500 V, 300 rpm D.C. generator. Assume the specific loading, B_{av} = 0.7 Wb/m^2. Ampere conductors/m = 40,000, square pole face, ratio of pole arc to pole pitch is 0.7. Assume efficiency as 92% and gap contraction factor as 1.15. **(12 Marks)**

2 a. Derive the output equation of a D.C. machine. Explain the factors to be considered during the choice of specific magnetic loading. **(08 Marks)**

b. Calculate the mmf required for the air gap of a machine having core length = 0.32 m including 4 ducts of 10 mm each, pole arc = 0.19 m, slot pitch = 65.4 mm, slot opening = 5 mm, air gap length = 5 mm, flux/pole = 52 mwb. Given Carter's coefficient is 0.18 for opening/gap = 1 and 0.28 for opening/gap = 2. **(12 Marks)**

3 a. Derive the output equation of a 3 phase core type transformer. Explain the choice of specific magnetic and electric loadings. **(10 Marks)**

b. A 100 KVA, 2000/400 V, 50 Hz, single phase, shell type transformer has the following particulars:
Maximum flux density = 1.1 wb/m^2, current density = 2.2 A/mm^2, window area constant K_w = 0.33, volt/turn = 11, core is rectangular and stampings are 7 cm wide. Length of window is equal to twice the width of window. Obtain:
i) Net iron area and window area   ii) Dimensions and weight of core.
Specific gravity of iron = 7.8 gram/cm^3. **(10 Marks)**

4 a. Derive an expression for the leakage reactance of transformer with primary and secondary cylindrical coils of equal length. **(10 Marks)**

b. A 250 KVA, 6600/400 V, three phase core type transformer has a total loss of 4800 watts at full load. The transformer tank is 125 cm in height and 100 × 50 cm in plan. Design a suitable scheme for tubes if the average temperature rise is to be limited to 35°C. The diameter of tubes is 5 cm and are spaced 7.5 cm from each other. The average height of tubes is 105 cm. **(10 Marks)**

PART – B

5 a. Discuss the various factors which influence the selection of airgap, stator and rotor slots in an induction motor. **(12 Marks)**

5 b. Select dimensions from the following range for a 25 HP, 400 V, 3 phase, 6 pole, 50 Hz induction motor. The mean gap density is not to exceed 0.45 wb/m^2 and specific electric loading is not to exceed 25000 Ampere conductors/m. Calculate also the turns per phase for the stator winding. The product of efficiency and power factor may be taken as 0.72, and the motor must be suitable for Y-Δ starting

Stator bore in m 0.25 0.3 0.36

$$\text{Core length in m} \quad \begin{cases} 0.10 & 0.12 & 0.19 \\ 0.14 & 0.16 & 0.18 \end{cases}.$$

Assume $K_w = 0.955$. **(08 Marks)**

6 a. With equations, explain the estimation of No-load current of a three phase induction motor. **(10 Marks)**

b. Calculate the equivalent resistance of rotor per phase referred to stator from the following data of a 400 V three phase, 4 pole, 50 Hz cage rotor. Stator slots 48, conductors/slot = 30, rotor slots = 53, one bar per rotor slot, length of each bar 12 cm, area of bar 0.6 cm^2, mean diameter of end rings18 cm, area of ring 1.5 cm^2 full pitch winding with 60^0 phase spread for stator. Specific resistance is 0.021 $\Omega/m.mm^2$. **(10 Marks)**

7 a. From the first principles, derive the output equation of 3 ϕ alternator interms of specific loadings, diameter and length of the stator core. What are the usual values of specific loadings? **(10 Marks)**

b. Determine a suitable number of slots and conductors per slot, for the stator winding of a 3 ϕ, 3300 V, 50 Hz, 300 rpm alternator. The diameter is 230 cm and the axial length of core is 35 cm. the maximum flux density in the air gap should be approximately 0.9 wb/m^2. Assume sinusoidal flux distribution. Use single layer winding and star connection for stator. **(10 Marks)**

8 a. Explain, in steps, the design of field winding of a salient pole synchronous machine. **(08 Marks)**

b. The following is the design data available for a 1250 KVA, 3 ϕ, 50 Hz, 3300 V, star connected, 300 rpm alternator of salient pole type. Stator bore D = 1.9 mt, stator bore length, L = 0.335 mt, pole arc/pole pitch = 0.66, turns/phase = 150, single layer concentric winding with 5 conductors per slot, short circuit ratio = 1.2. Assume that the distribution of gap flux is rectangular region. Calculate :

i) Specific magnetic loading ii) Armature mmf per pole

iii) Gap density over pole arc iv) Air gap length

mmf required for air gap is 0.88 of No-load field mmf and the gap contraction factor is 1.15. **(12 Marks)**

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