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06EE63

Sixth Semester B.E. Degree Examination, June 2012
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. What are the desirable properties of insulating materials? Explain the classification of insulating materials based on the thermal consideration with two examples of each. **(12 Marks)**

b. From first principles deduce an expression for output equation of a DC machine. **(08 Marks)**

2 a. Give the step by step procedure of designing a shunt field coil for a DC machine. **(10 Marks)**

b. Calculate the diameter and length of armature for a 7.5 kW, 4 pole, 1000 rpm, 220 V DC shunt motor. Given full load efficiency = 0.83, Maximum flux density = 0.9 Wb/m^2; Specific electric loading = 30000 AC/m field form factor = 0.7. Assume that the maximum efficiency occurs at full load and field current is 2.5% of rated current. The pole face is square. **(10 Marks)**

3 a. Derive an expression for volts/turn of transformer. **(05 Marks)**

b. Obtain an expression for no load current of 1 ϕ transformer. **(05 Marks)**

c. Calculate the approximate overall dimensions for a 200 KVA, 6600/440 V, 50 Hz, 3 ϕ core type transformer for the following data:
emf/turn = 10 V; Maximum flux density = 1.3 T; Current density = 2.5 A/mm^2; Window space factor = 0.3; Overall height = Overall width; Iron stacking factor = 0.9. Use 2 stepped core. **(10 Marks)**

4 a. Write an expression for leakage reactance of a core type transformer and state the assumptions made. **(12 Marks)**

b. The full load efficiency of a 300 KVA 1 ϕ core type transformer is 98.2% at UPF. Design the number of cooling tubes necessary if the temperature rise is 35°C. The tank area may be assumed as 4.92 m^2. Assume the tube diameters as 5 cm and average length of 105 cm. Heat dissipation may be assumed as 12.5 $W/m^2/°C$ **(08 Marks)**

PART – B

5 a. Discuss the factors to be considered while designing the length of air gap for an induction motor. **(10 Marks)**

b. Estimate the stator core dimensions, number of stator slots, and number of stator conductors per slot for a 100 kW, 3300 V, 50 Hz, 12 pole, star connected slip ring induction motor. Take the average gap density of 0.4 Wb/m^2, ac/m, 25000, efficiency = 90 %, power factor = 0.9 and winding factor = 0.96. Choose the main dimensions to give best p.f. the slot loading must not exceed 500 ac. **(10 Marks)**

6 a. A 3ϕ, 4 pole, 50 Hz induction motor has 24 stator slots and 28 rotor slots. Prove that it has a tendency to run as synchronous motor at a speed of 214.3 rpm. **(08 Marks)**

b. A 15 kW, 3ϕ, 6 pole, 50 Hz cage motor has the following data: D = 0.32 m; L = 0.125 m; Number of stator slots = 54; Number of conductors/slot = 24; Current in each conductor 17.5 A; Full load pf = 0.85 (lag). Design a suitable cage rotor giving number of rotor slots, section of each rotor bar and end ring and effective resistance of the rotor. Given the full load speed as 950 rpm. Resistivity of copper as 0.02 Ω mm^2/m. **(12 Marks)**

7 a. Define SCR and explain its effect on synchronous machine performance. **(10 Marks)**

b. During the design of stator for a 3ϕ, 7.5 KVA, 6.6 KV, 50 Hz, 3000 rpm, turbo alternator following information have been obtained.
Internal diameter of stator = 0.75 m
Gross core length = 0.9 m
Number of stator slots/pole/ph = 7
Sectional area of stator conductor = 190 mm^2
Number of conductors per slot = 4
Based on the above data calculate
i) flux/pole ii) specific loadings iii) current density for stator winding **(10 Marks)**

8 a. Discuss the factors to be considered while selecting suitable number of armature slots in a synchronous machine. **(06 Marks)**

b. Give the procedure of estimating air gap length in a synchronous machine. **(06 Marks)**

c. Find the main dimensions of a 100 MVA, 11 KV, 50 Hz, 150 rpm, 3ϕ water wheel generators. Given B_{av} = 0.65 Wb/m^2; ac/m = 40000. The peripheral speed should not exceed 65 m/sec at normal running speed in order to limit the runaway speed. Assume K_w = 0.955. **(08 Marks)**

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