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06E263

Sixth Semester B.E. Degree Examination, May/June 2010
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note:1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Design data book may be used if necessary.

PART – A

1 a. Explain specific loadings and usual range of values for each of the loading. **(05 Marks)**
b. Explain the various factors that affect choice of poles of a DC machine. **(08 Marks)**
c. What are the desirable properties of insulating materials? Explain the classification of insulating materials based on thermal consideration. **(07 Marks)**

2 a. Define specific electrical and magnetic loadings for DC machines. Derive the output equation of DC machine both as motor and generator. **(10 Marks)**
b. A 250kW, 500V, 600rpm dc generator is built with an armature diameter of 0.75m and a core length of 0.3m. The lap connected armature has 720 conductors. Using data obtained from this machine, determine the armature diameter, core length, number of armature slots, armature conductors and commutator segments for a 350 kW, 440V, 720 rpm, 6 pole DC generator. Assume a square pole face with ratio of pole – arc to pole pitch = 0.66. The full load efficiency is 0.91 and the internal voltage drop is 4% of rated voltage. The diameter of commutator is 0.7 of armature diameter. The pitch of commutator segments should not be less than 4mm. The voltage between adjacent segments should not exceed 15V. **(10 Marks)**

3 a. Calculate the size of conductor and number of turns for the field coil of a 6 pole, 460V, dc shunt motor. The coil is to supply a mmf of 4000AT, at working temperature. The length of the inside turn is 0.74m, length available for winding is 0.13m, the space factor of the winding is 0.52, and the permissible dissipation from external surface excluding ends is $1200 W/m^2$. Solution should not be attempted by assuming winding depth. The resistivity of conductors is $0.02 \Omega m / mm^2$. Keep 15% of applied voltage as reserve for speed control. **(12 Marks)**
b. Calculate the apparent flux density at a particular section of the tooth from the following design data : tooth width = 12mm ; slot width = 10mm ; gross core length = 0.32m ; number of ventilating ducts = 4 , each 10mm wide ; real flux density = $2.2 wb/m^2$; permeability of teeth corresponding to real flux density = 31.4×10^{-6} H/m ; stacking factor = 0.9. **(08 Marks)**

4 a. Determine the main dimensions and winding details of a 100 KVA, 2000/400 V, 50Hz, single – phase shell – type oil – immersed self cooled transformer. Assume voltage per turn = 10V, flux density in the core = $1.1 wb/m^2$, current density= $2A/mm^2$, window – space factor = 0.33. The ratio of window height to window width, as well as ratio of core depth to width of central limb = 2.5. Stacking factor = 0.9. **(10 Marks)**
b. Derive an expression for leakage reactance of a transformer with primary and secondary cylindrical coils of equal length, stating clearly the assumptions made. **(10 Marks)**

PART - B

5 a. Derive the output equation of a 3-phase induction motor. What are the usual values of specific loadings? **(10 Marks)**

b. Determine the main dimensions, number of radial ventilating ducts, number of stator slots and number of turns per phase of a 3.7kW, 400V, 3 ϕ, 4 pole, 50 Hz, cage induction motor, to be started by a star – delta starter. Assume B_{av} = 0.45wb/m^2 ; ac/m = 23000, efficiency = 0.85 and power factor = 0.84 lagging. **(10 Marks)**

6 a. Discuss in detail, the criteria to be considered for determining the number of rotor slot of a cage induction motor. **(10 Marks)**

b. A 15kW, 3 – phase, 6 pole, 50Hz, cage induction motor has following data : D = 0.32m ; L = 0.125m, number of stator slots = 54, number of conductors per slot = 24, current in each conductor is 17.5A, full – load power factor is 0.85 lagging. Design a suitable cage rotor giving number of rotor slots, section of each bar, and section of each end ring. Also calculate the effective resistance of the rotor. The full-load speed is about 950rpm, resistivity of copper is 0.02Ω mm^2/m. **(10 Marks)**

7 a. What is SCR of a synchronous machine? What are the effects of SCR on machine performance? **(10 Marks)**

b. Find the main dimensions of a 100 MVA, 11KV, 50Hz, 150rpm, 3ϕ, water wheel generator. Given that B_{av} = 0.65 wb/m^2 and ac/m are 40000. The peripheral speed should not exceed 65m/s at normal running speed in order to limit runaway speed. **(10 Marks)**

8 Write short notes on the following :

a. Cooling of transformers. **(05 Marks)**

b. No – load current estimation for a 3ϕ induction motor from design data. **(05 Marks)**

c. Design procedure for designing the field winding of a salient pole alternator. **(05 Marks)**

d. Cogging and crawling of 3ϕ induction motor. **(05 Marks)**

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