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10EE63

Sixth Semester B.E. Degree Examination, June/July 2018
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Mention the desirable properties of electrical insulating materials. Also give the classification of insulation materials based on temperature with an example for each. **(10 Marks)**

b. Define specific electrical and magnetic loadings for DC machines. Derive the output equation of DC machine both as motor and generator. **(10 Marks)**

2 a. Explain factors that influence the choice of number of poles in case of a d.c. machine. **(10 Marks)**

b. A shunt field coil has to develop an mmf of 9000 A. The voltage drop in the coil is 40V, and the resistivity of round wire used is 0.021 Ω/m and mm^2. The depth of winding is 35 mm approximate and the length of mean turn is 1.4 m. Design a coil so that the power dissipated is 700 W/m^2 of the total coil surface (i.e., outer, inner, top and bottom). Take the diameter of the insulated wire 0.2 mm greater than that of bare wire. **(10 Marks)**

3 a. Derive the output equation of a 3-phase core type transformer. **(10 Marks)**

b. Calculate approximate overall dimensions for a 200 kVA, 6600/440V, 50Hz, 3-ϕ core type transformer. The following data may be assumed :
emf/turn = 10 V ; maximum flux density = 1.3 Wb/m^2 ; current density = 2.5A/mm^2.
Window space factor = 0.3 ; overall height = overall width ; stacking factor = 0.9.
Use a 3-stepped core ; Width of largest stamping = 0.9 d and net iron area = 0.6 d^2, where 'd' is the diameter of circumscribing circle. **(10 Marks)**

4 a. 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)**

b. A 1000 kVA, 6600/440 V, 50 Hz, 3-d Δ/Y, core type, oil immersed, natural cooled (ON) transformer. The design data of the transformer is Distance between centres of adjacent limbs = 0.47m, outer diameter of high voltage winding = 0.44 m, height of frame = 1.24 m, core loss = 3.7 kW and I^2R loss = 10.5 kW. Design a suitable tank for the transformer. The average temperature rise of oil should not exceed 35°C.

The specific heat dissipation from the tank walls is 6 W/m^2 °C and 6.5 W/m^2 °C due to radiation and convection respectively. Assume that the convection is improved by 35% due to provision of tubes. **(10 Marks)**

PART – B

5 a. Explain the factors to be considered while selecting length of airgap in an induction motor. **(10 Marks)**

b. 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. Assume : Average flux density in the airgap = 0.45 Wb/m^2, ampere conductors per metre = 23000, efficiency = 0.85 and power factor = 0.84. Ratio of length to pole pitch = 1.5. **(10 Marks)**

6 a. A 90 kW, 500 V, 50 Hz, 3-ϕ, 8 pole induction motor has a star connected stator winding accommodated in 63 slots with 6 conductors/slot. If the slipring voltage on open circuit is to be about 400 V, find a suitable rotor winding, stating (i) Number of slots, (ii) Number of conductors/slots, (iii) Coil span, (iv) Slipring voltage on open circuit (v) Approximate full load current/phase in rotor. Assume efficiency = 0.9, p.f. = 0.86. **(10 Marks)**

b. Find the magnetizing current, no load current, no load power factor of a 15 HP, 440 V, 6 pole, delta connected slip ring induction motor having the following data : Number of stator slots = 54, conductors/slot = 28, flux/pole = 8.25 MWb, gap area/pole = 183.5 cm^2 , gap length = 0.55 mm, iron losses = 510 W, friction and windage losses = 110 W, gap expansion coefficient = 1.33. Iron parts of magnetic circuit requires 20% of ATS required for the gap k_{w1} = 0.96. **(10 Marks)**

7 a. Define short circuit ratio and explain the effects on the design of an alternator. **(10 Marks)**

b. Determine a suitable number of slots and conductors per slot for the stator winding of a 3-phase, 3300 V, 50 Hz, 300 rpm alternator. The diameter is 2.3 m and the axial length of core is 0.35 m. The maximum flux density in the airgap should be approximately 0.9 Wb/m^2. Assume sinusoidal flux distribution. Use single layer winding and star connection for stator. **(10 Marks)**

8 Write short notes on any four :

a. Factors to be considered in selection of number of slots in synchronous machines

b. Cooling of transformer

c. Cogging and crawling of induction motor

d. Magnetic materials used in electrical machines

e. Design procedure for designing of field winding of a salient pole alternator. **(20 Marks)**

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