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10EE63

Sixth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Draw figures wherever necessary.***
3. ***Assume suitable values for any missing data.***

PART – A

1 a. What are the desired properties of insulation materials used in electrical machines? Name some insulation materials and state where they are utilized. **(04 Marks)**

b. Derive the output equation of a D.C. machine. **(06 Marks)**

c. Calculate the diameter and length of armature core of a 70 kW, 240 V, 900 rpm, 4 pole D.C. shunt generator. The average flux density is 0.7 webers/metre^2 and AC/m is 34,000. The ratio of core length to pole pitch is 0.8. Full load armature drop is 9.6 V and field current is 3.0 Amperes. **(10 Marks)**

2 a. Discuss the factors which influence the selection of, i) number of poles ii) number of slots iii) air gap of a DC machine. **(06 Marks)**

b. Discuss why the armature core, field poles of a D.C. machine are laminated, while yoke is not normally laminated. **(04 Marks)**

c. A shunt field coil has to develop an mmf of 9000 AT. The voltage drop in the coil is 40 V and resistivity of round wire used is 0.021 ohms/meters/mm^2. Depth of winding is 35 mm approximately and 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 (outer, inner top and bottom). Take the diameter of the insulated wire to be 0.2 mm greater than the bare copper. **(10 Marks)**

3 a. Show that the output of a 3 phase core type transformer is $5.23\ f.B_m H.d^2 H_W \times 10^{-3}$ KVA where 'f' is the frequency, B_m – the maximum value of flux density in webers/m^2, d is the effective diameter of the core in meters, H is the magnetic potential gradient in the limit in amperes/metre and H_W is the height of window in meteres. **(10 Marks)**

b. The ratio of flux to full load mmf in a 400 KVA 50 Hz, single phase core type power transformer is 2.4×10^{-6}. Calculate the net cross area and the window area of the transformer maximum flux density in the core is 1.3 weber/metre^2, current density 2.7 A/mm^2 and window space factor is 0.26. Also calculate the full load mmf. **(10 Marks)**

4 a. For a constant total volume of conductors in a transformer. Show that for a minimum copper loss, current densities in the windings must be equal. **(04 Marks)**

b. A single phase, 400 V, 50 Hz transformer is built from stampings having a relative permeability of 1000. Length of flux path is 2.5 m, area of cross section of the arc is 2.5×10^{-3} metre^2 and the primary winding has 800 turns. Estimate the maximum flux and no load current of the transformer. Given loss at working flux density is 2.6 w/kg. Given weighs 7.8×10^3 kg/m^3. Stacking factor is 0.9. **(08 Marks)**

c. A 3 phase, 50 Hz oil cooled core type transformer has the following dimensions. Distance between core centres 0.2 m, height of window 0.24 m. Diameter of circumscribing circle is 0.14 m. Flux density in the core is 1.25 Wb/m^2 and the current density in the conductors is 2.5 A/mm^2. Estimate the KVA rating. Assume a window space factor of 0.2 and a core area factor of 0.56, core is 2 stepped. **(08 Marks)**

PART – B

5 a. Discuss the factors to be considered while choosing the number of slots for the rotor of an induction motor. **(04 Marks)**

b. What are the effects of increasing the air gap of an induction motor? **(04 Marks)**

c. A 30 H.P., 3 phase, 440 V, 960 rpm, 50 Hz delta connected induction motor, has a specific, electric loading of 25,000 AC/m and a specific magnetic loading of 0.46 webers/metre^2. The full load efficiency is 86%, pf is 0.87, Pole pitch core length = 1. Find following : i) Stator core dimensions ii) Number of stator slots and the number of turns in the stator winding. **(12 Marks)**

6 a. Discuss the advantages of skewing the rotor slots in an induction motor. **(04 Marks)**

b. What are the factors to be considered while designing the rotor of a slip ring induction motor? **(04 Marks)**

c. A 90 kw, 500 V, 50 Hz, 3 phase induction motor has a star connected, stator winding accommodated in 63 slots with 6 conductors/slot. If the slip ring voltage on open circuit is to be about 400 V, find a suitable rotor winding stating,
i) Number of slots ii) Number of conductors/slot iii) Coil span iv) Approximate full load current per phase in rotor. Assume efficiency of 90% and p.f. of 0.86. **(12 Marks)**

7 a. Discuss the factors which influence the selection of stator (armature) slots in an alternator. **(05 Marks)**

b. Derive the output equation of an alternator. **(05 Marks)**

c. Design suitable values of diameter and length of a 75 MVA, 11 KV, 50 Hz, 3000 rpm, 3 phase star connected alternator. Also determine the value of flux, conductors / slot, number of turns / phase and size of armature conductors.
Given :
Average gap density = 0.6 webers/meter^2
Ampere conductors/meter = 50,000
Peripheral speed = 180 metres/sec
Winding factor = 0.95
Current density = 6 A/mm^2 **(10 Marks)**

8 a. Define SCR and explain its effect on machine performance. **(08 Marks)**

b. The field coils of a salient pole alternator are wound with a single layer winding of a bare copper strip of 30 mm deep, with separating insulation of 0.15 mm thick. Determine a suitable winding length, number of turns and thickness of conductors to develop an mmf of 12000 AT with a potential difference of 5 volts per coil and with a loss of 1200 watts/metre^2 of total coil surface. The mean length of turn is 1.2 m and resistivity of copper is 0.021 Ω/m/mm^2. **(12 Marks)**

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