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10EE63

Sixth Semester B.E. Degree Examination, June/July 2019
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 major considerations to evolve a good electrical machine design? **(06 Marks)**

b. What are the desirable properties of insulating materials? **(04 Marks)**

c. Determine the number of poles, armature diameter and core length for the preliminary design of 500 kW, 400 V, 600 rpm, D.C. shunt generator. Assuming an average flux density in the air gap of 0.7 Wb/m^2 and specific electric loading of 38400 A/m. Take core length to pole arc = 1.1. **(10 Marks)**

2 a. Estimate the AT/pole required for the air gap of a 500 V, 6 pole, 300 rpm, lap connected DC machine. The armature core having 90 slots is 30 cm long. The pole pitch is 50 cm and pole arc is 33 cm. The air gap length may be taken as 5 mm. There are 16 conductors per slot of width 1.3 cm. Assuming 5 vertilating ducts, each of 1 cm wide. The carter's coefficient is 0.66 and 0.72 for slot / width gap of 2.6 and 2.0 respectively. **(10 Marks)**

b. The following are, particulars refer to the shunt field coil for a 440 V, 6 pole, DC generator, mmf/pole = 7000 A, Depth of winding is 50 mm, length of inner turn = 1.1 m. length of outer turn = 1.4 m, loss radiated from outer surface = 1400 W/m^2, Space factor = 0.62, resistivity = 0.02 Ω/m/mm^2. Calculate the

(i) Diameter of the wire. (ii) Length of coil.
(iii) Number of turns (iv) Exciting current.

Assume voltage drop of 20% of terminal voltage across field regulator. **(10 Marks)**

3 a. Derive the output equation of 3-ϕ shell type transformer. **(08 Marks)**

b. Calculate overall dimensions for a 200 KVA, 6600/440 V, 50 Hz. Three phase core type transformer. The following data may be assumed:

Volt per turn $E_t = 10V$; $B_m = 1.3$ Wb/m^2, $\delta = 2.5$ A/mm^2, $K_W = 0.30$,

Overall Height = Overall width, Use a three stepped core.

(Given a = 0.90 d; b = 0.70 d; c = 0.42 d; d = diameter of circumscribing circle. Net iron Area Ai = 0.60 d^2)

Also draw the diagram showing all the overall dimensions. **(12 Marks)**

4 a. A 15000 KVA, 33/6.6 KV, Three phase Star / Delta core type transformer has the following data: Area of cross section of core limit = 0.15 m^2, Area of cross section of the yoke = 0.18 m^2, length of flux path in each limb = 2.3 m, each yoke = 1.6 m, Number of turns in HV winding = 450, AT/m in core leg is 540 A/m and the yoke is 260 A/m as obtained from magnetization curves; loss per kg in iron is 2.5 W/kg in limit and 1.4 W/kg in yoke. Density of iron is 7.8 g/CC. Estimate the no load current per phase. **(10 Marks)**

b. Design an adequate cooling arrangement for a 250 KVA, 6600/400 V, 50 Hz, 3-ϕ Delta/star core type oil immensed natural cooled transformer with the following particular:

(i) Winding temperature not to exceed 50°C
(ii) Total loss at 90°C are 5 kW.
(iii) Tank dimensions, Height × length × Width = 125 × 100 × 50 (All in cm).
(iv) Oil level = 115 cm length.

Sketch the diagram to show the arrangement of cooling tubes. **(10 Marks)**

PART – B

5 a. What are the usual values of specific loadings? With usual notations derive the output equation of a three phase induction motor. **(10 Marks)**

b. Determine the main dimensions, turns per phase and number of slots of a 250 Hp, 3-ϕ, 50 Hz, 400 V, 1410 rpm slip ring. Induction motor. Assume Bav = 0.5 Wb/m^2, (ac) = 30000 A/m; $\eta = 0.9$, p.f. = 0.9, Kw = 0.955, Ratio of core length to pole Pitch = 1.2. The machine is Delta connected. **(10 Marks)**

6 a. A 11 kW, Three phase, 6 pole, 50 Hz, 220 V, star connected induction motor has 54 stator slots each containing 9 conductors. Calculate the values of bar and end ring currents. The number of rotor bars is 64. The machine has an efficiency of 0.86 and a power factor of 0.85. The rotor mmf may be assumed to be 85% stator mmf. Also find the bar and end ring sectional areas if the current density is 5 A/mm^2. **(10 Marks)**

b. A 15 kW, 400 V, Three phase, 50 Hz, 6 pole induction motor has a diameter is 0.3 m, and core length of 0.12 m. The number of stator slots are 72, with 20 conductors per slot. Calculte the value of magnetizing current per phase if the length of air gap is 0.55 mm. The gap contaction factor is 1.2. Assume that mmf required for the iron parts is 35% in the air gap. Coil span = 11 slots. **(10 Marks)**

7 a. Explain the choice of specific magnetic and electric loadings in design of synchronous machine. **(10 Marks)**

b. Determine for a 500 KVA, 6600 V, 12 pole, 500 rpm, star connected salient pole alternator suitable value for,

(i) Diameter at the air gap.
(ii) Core length.
(iii) Number of stator slots.
(iv) Number of conductors.

Assume specific electric loading as 30000 A/m, specific magnetic loading as 0.60 Wb/m^2. Core length is 0.65 times pole pitch. Winding factor = 0.955. **(10 Marks)**

8 a. What are the methods employed to eliminate harmonics from the generated voltages in design of synchronous machine? Explain. **(10 Marks)**

b. A 588 MVA, 22000 V, 50 Hz, three phase star connected direct water cooled generator has a stator bore of 1.3 m and a stator core length of 6.0 m. If the stator winding has 2 conductors / slot, and there are two circuits / phase, calculate

(i) Number of stator slots.
(ii) Average flux density in the gap,

Assume specific electric loading as 20000 A/m and winding factor of 0.92. **(10 Marks)**

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