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10EE63

Sixth Semester B.E. Degree Examination, June/July 2017
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Any missing data may be suitably assumed.***
3. ***Design data book may be used if necessary***

PART – A

1 a. Discuss the factors which imposes limitations on design. **(06 Marks)**

b. What are the desirable properties of insulating materials? Explain the classification of insulating materials based on thermal considerations with two examples on each class. **(08 Marks)**

c. Explain the terms specific loadings in the design of electrical machines. **(06 Marks)**

2 a. Determine the main dimensions of the armature core, number of ventilating ducts, number of conductors of a 350 KW, 500 V, 450 rpm, 6 pole, shunt generator assuming square pole faces with pole arc 70% of pole pitch. Assume the mean flux density to be 0.7 T and ampere-conductor per centimeter to be 280. **(10 Marks)**

b. A 8 pole, 500 V, DC shunt generator with all the field coils connected in series requires 5000 AT/pole. If the poles are of rectangular dimensions 12×20 cm and winding cross section is 12×2.5 cm, determine the C/S area of wire, number of turns, dissipation in watts/cm^2 based on outside and two end surfaces of the coil. The conductor of circular C/S is used. Resistivity is 0.021 ohm/m/mm^2 and insulation increases the diameter by 0.02 cm. Allow a voltage drop in the field regulator of 50 V. **(10 Marks)**

3 a. Derive the output equation of a three phase core type transformer. **(06 Marks)**

b. Prove that emf per turn of a single phase transformer = $K\sqrt{KVA}$. **(04 Marks)**

c. Calculate the dimensions of the core, the number of turns and C/S area of the conductor for a 100 KVA, 2300/400 V, 50 Hz, single phase shell type transformer assuming ratio of magnetic to electric loading as 480×10^{-8}; Maximum flux density in the core is 1.1 T; Current density is 2.2×10^6 A/m^2; Window space factor is 0.3; ratio of depth of stacked core to width of central limb is 2.6; $H_w / W_w = 2.5$; $K_i = 0.9$. **(10 Marks)**

4 a. A 250 KVA, 6600/440 V, 50 Hz, Three phase star delta, core type transformer gave the following results during design calculations: length + twice the height of yoke = 85 cm; Centre to Centre distance of the core = 32 cm; Outside diameter of HV winding = 31 cm; Total iron loss = 1500 W; Total copper loss = 3750 W. Calculate

(i) The dimension of the tank
(ii) The temperature rise of the transformer.
(iii) The number of cooling tubes if the temperature rise is not to exceed 35°C. **(10 Marks)**

b. Calculate the No load current and power factor of a 3300/220 V, 50 Hz, single phase core type transformer with the following data:
Mean length of magnetic path = 300 cm; Gross area of iron core = 150 cm^2; Specific iron loss at 50 Hz and 1.1 T is 2.1 W/kg; Ampere turns/cm for transformer steel at 1.1 T is 6.2. The effect of joints is equivalent to that of an airgap of 1 mm in the magnetic circuit. Density of iron is 7.55 gm/CC and iron factor is 0.92. **(10 Marks)**

PART – B

5 a. Explain the factors which influence the choice of length of airgap of a induction motor. **(08 Marks)**

b. Determine the diameter of stator bore and core length of a 70 HP, 415 V, Three phase, 50 Hz, star connected, 6 pole, induction motor for which q = 32000 AC/m, $B_{av} = 0.51T$. Take efficiency as 90% and power factor as 0.91. Assume pole pitch equal to core length. Estimate the number of stator conductor required for a winding in which the conductors are connected in two parallel paths. Choose a suitable number of conductors / slot so that the slot loading does not exceed 750 amp-conductors. **(12 Marks)**

6 a. Discuss the design procedure for slip ring rotor of a 3 phase induction motor. **(08 Marks)**

b. Calculate the equivalent resistance of rotor per phase with respect to stator, the current in each bar and end ring and the total rotor copper loss for a 415 V, 50 Hz, 4 pole, 3 phase Induction motor having the following data:
Stator : Slots = 48, Conductors / Slot = 35, Current in each conductor = 10 Amp.
Rotor : Slots = 57, length of each bar = 0.12 m, area of each bar (9.5×5.5) mm^2, Mean diameter of end ring = 0.2 m, area of each end ring = 175 mm^2; Resistivity of copper is 0.02 ohm/m/mm^2, full load power factor is 0.85. **(12 Marks)**

7 a. Derive the output equation of a synchronous machine interms of its main dimension and specific loadings. **(08 Marks)**

b. During the design of stator of a 3 phase, 7.5 MVA, 6.6 KV, star connected, 50 Hz, 3000 rpm, turbogenerator, following information have been obtained : D = 0.75 m; L = 0.9 m; Number of slots/pole/phase = 7; C/S area of stator conductor = 190 mm^2; number of stator conductor per slot = 4. Calculate (i) flux per pole (ii) Average flux density (iii) Specific electric loading (iv) Current density. **(12 Marks)**

8 a. Explain the factors to be considered in the selection of number of armature slots of a synchronous machine. **(08 Marks)**

b. A 1250 KVA, 3300 V, 50 Hz, 250 rpm, 3 phase, star connected alternator having two parallel path/phase has 216 slots with 8 conductors/slot. Single layer winding with full pitch coils is used. Determine the specific magnetic and electric loadings if the diameter is 240 cm and axial length is 41.4 cm. Using the same loadings and other relevant data with marginal modifications if necessary find D, L, Z_1, S_1 and conductors/slot of a star connected 1000 KVA, 3300 V, 50 Hz, 300 rpm, 3 phase alternator having single layer winding with full pitch coils and with no parallel circuits in phase winding. The machine have 60° phase spread. **(12 Marks)**

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