CBCS SCHEME

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15EE64

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Electrical Machine Design

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing one full question from each module.
2. Missing data, if any, may be suitably assumed.

Module-1

1 a. Explain the clearly the factors which impose limitations on the design of electrical machines. **(08 Marks)**

b. Discuss modern machine manufacturing techniques in the design of electrical machines. **(08 Marks)**

OR

2 a. What are the desirable properties of insulating materials used in electrical machines? Give the classification of insulating materials based on thermal considerations with examples of materials used in each class. **(08 Marks)**

b. What are desirable properties of conducting materials used in electrical machines? Explain any two conductors with their properties. **(08 Marks)**

Module-2

3 a. Discuss the various factors which govern the choice of number of poles in DC machines. **(08 Marks)**

b. Find the main dimensions and the number of poles of a 37 kW, 230 V, 1400 rpm shunt motor so that a square pole face is obtained. The average gap density is 0.5T and ampere-conductor per metre is 22000. The ratio of pole arc to pole pitch is 0.7 and full load efficiency is 90%. **(08 Marks)**

OR

4 a. Discuss the design of shunt field winding of a DC machines. **(06 Marks)**

b. A 8 pole, 500V, 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 cross sectional area of wire, number of turns and dissipation in watts/cm^2 based on the outside and two end surfaces of the coils. The conductor of circular cross section is used. $\rho = 0.021\ \Omega/m/mm^2$ and insulation increases the diameter of conductor by 0.02 cm. Allow a voltage drop in the field regulator of 50V. **(10 Marks)**

Module-3

5 a. Derive the output equation of a 3 phase core type transformer. Also derive the volts per turn equation. **(08 Marks)**

b. Determine the main dimensions of core and window, number of turns and cross sectional area of the conductors of a primary and secondary winding of a 3 phase core type transformer, 350 kVA, 11000/3300V, star-delta, 50 Hz. Assume volts/turn = 11; Maximum flux density = 1.25T; $A_i = 0.6\ d^2$; a = 0.9 d ; window space factor = 0.27; $H_w = 3W_W$, current density = 2.5 A/mm^2. **(08 Marks)**

OR

6 a. Discuss the design of tank and cooling tubes of a transformer. **(08 Marks)**

b. Calculate the No-load current a power factor of a 3300/220V, 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 1.1T 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. Iron factor is 0.92. **(08 Marks)**

Module-4

7 a. Discuss the factor affecting the length of airgap of a 3 phase induction motor. **(06 Marks)**

b. Determine the diameter of stator bore and core length of a 70 HP, 415 V, 3 phase, 50 Hz, star connected, 6 pole, induction motor for which q = 32,000 A-c/m, B_{av} = 0.51 T. Take efficiency as 90% and power factor as 0.91. Assume pole pitch is equal to core length. Estimate the number of stator conductors required for a winding in which the conductors are connected in 2 parallel paths. Assume number of slots/pole/phase = 3. **(10 Marks)**

OR

8 a. Derive expression for rotor bar and end ring current of squirrel cage induction motor. **(06 Marks)**

b. Discuss design of slip-ring rotor of a 3 phase induction motor. **(05 Marks)**

c. Determine the Magnetizing current, No load current and power factor of a 15 HP, 6 pole, 440 V, delta connected slip ring. Induction motor having the following data:
Number of stator slots = 54, stator conductor per slot = 28, flux/pole = 8.25 milliwaber, airgap area/pole 183.5 cm^2, gap length = 0.55 mm, iron loss = 510 W; friction and windage loss =110 W; gap contraction coefficient = 1.33, iron parts of the magnetic circuit requires 20% of ampere turns required for gap. Stator winding factor = 0.96. **(05 Marks)**

Module-5

9 a. Derive the output equation of a 3 phase synchronous machine. **(08 Marks)**

b. Determine the main dimensions of the stator bore, number of stator conductors and slots of a 3 phase, star connected, 8 pole, alternator rated at 300 kVA, 50 Hz. Assume q = 280 A-c/cm B_{av} = 0.6T, square pole faces and pole arc = 0.65 pole pitch. Voltage rating = 3300 V. Take number of slots/pole/phase = 3.5. **(08 Marks)**

OR

10 a. Discuss the factors to be considered while selecting number of armature slots in a synchronous machine. **(06 Marks)**

b. What are the steps involved in the design of field winding of a salient pole alternator? **(06 Marks)**

c. A 500 kVA, 3.3 kV, 50 Hz, 600 rpm, salient pole alternator has 180 turns/phase. Estimate the length of airgap if the average flux density = 0.575 Wb/m^2. Pole arc/pole pitch = 0.66, SCR = 1.2, gap extension factor = 1.15. The mmf required for the gap is 82% of the No load field mmf. KW_1 = 0.955. **(04 Marks)**

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