CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, Jan./Feb. 2023
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

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

b. What are the limitations in the design of electrical machines? **(05 Marks)**

c. List out the desirable properties of conducting materials. **(05 Marks)**

OR

2 a. What are the advantages of modern trends in design and manufacturing technique? **(08 Marks)**

b. What are good properties of magnetic materials? **(06 Marks)**

c. What is cold rolled grain oriented Silicon Steel? What are advantages of using these materials in electrical machines? **(06 Marks)**

Module-2

3 a. Discuss the effect of higher values of magnetic and electric loading in DC machines. **(10 Marks)**

b. Explain the guiding factors for choice of number of armature slots in d.c. machines. **(10 Marks)**

OR

4 a. Discuss the various factor which govern the choice of number of pole in DC machine. What are the advantages and disadvantages of large number of poles in DC machines? **(10 Marks)**

b. Find the main dimensions and 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 0.5 T an ampere conductor/m is 22000. The ratio of pole arc to pole pitch is 0.7 and full load efficiency is 90%. **(10 Marks)**

Module-3

5 a. Derive the output equation of 3 phase core type transformer. Also derive the volt per turn equation. **(10 Marks)**

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

OR

6 a. Derive an expression for leakage reactance of a transformer with primary and secondary cylindrical coil of equal length, stating clearly all the assumptions made. **(10 Marks)**

b. The tank of 250 KVA, natural oil cooled transformer has the dimension length, width and height as 0.65 × 1.55 × 1.85 respectively. The full load loss is 13.1 KW, loss of dissipation due to radiation is 6 W/m^2-°C, loss dissipation due to convection is 6.5 W/m^2-°C, improvement in convection due to provision of tubes is 40%, temperature rise is 40°C, length of each tube = 1 m, diameter of tube is 50 mm. Find the number of tubes for this transformer. Neglect the top and bottom surface of the tank as regards the cooling. **(10 Marks)**

Module-4

7 a. What are factors to be considered for estimating the length of air gap for induction motors? **(10 Marks)**

b. Determine the main dimensions of a 70 HP, 415 V, 3-ϕ, 50 Hz, star connected, 6 pole induction motor for which ampere conductor/m = 30000 and B_{av} = 0.51 T. Take efficiency = 90% and power factor = 0.91. Assume pole pitch, τ = L. Estimate the number of stator conductors required for winding in which the conductors are connected in 2-parallel paths. Choose suitable number of conductors/slot, so that slot loading does not exceed 750 ampere conductors. **(10 Marks)**

OR

8 a. Explain the step by step procedure to design end rings. **(08 Marks)**

b. Find the magnetizing current, no load current, no load power factor of 15 HP, 440 V, 6 pole, delta connected slip ring inductor motor having 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 MW, 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. **(12 Marks)**

Module-5

9 a. Discuss the effect of SCR on the performance of synchronous machines. **(06 Marks)**

b. Explain the factors affecting choice of specific electric and magnetic loading. **(08 Marks)**

c. A 500 KVA, 33 KV, 50 Hz, 600 rpm, 3 ϕ salient pole alternator has 180 turns/ph. Estimate length of air gap, if average flux density is 0.54 T. The ratio pole arc to pole pitch is 0.66, the short circuit ratio is 1.2, gap construction factor is 1.15 and K_w = 0.955. The mmf required for air gap is 80% of no field mmf. **(06 Marks)**

OR

10 a. Explain the design procedure involved in the design of field winding of a salient pole alternator. **(06 Marks)**

b. Derive the output equation of synchronous machine and show that

$$HP = \frac{\text{input KVA} \times \eta \times \cos\phi}{0.746}$$ **(08 Marks)**

c. Estimate diameter, core length and number of conductors for a 15 MVA, 11 KV, 50 Hz, 2 pole, star connected turbo alternator with phase spread 60°. Assume B_{av} = 0.55 T, ac = 36000 A/m, δ = 5 A/mm^2, V_a = 160 m/s. The winding designed to eliminate 5th harmonic. **(06 Marks)**

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