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Question Paper Code : 50506

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Sixth Semester

Electrical and Electronics Engineering

EE 8002 — DESIGN OF ELECTRICAL APPARATUS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Draw the magnetic circuit of DC machine.
2. Mention the two types of armature winding used in dc machine and compare.
3. What are the advantages of stepped core in transformer and why it is generally used?
4. What causes temperature rise in transformers?
5. Define specific magnetic loading and give the ranges for DC machine design.
6. Mention the factors governing the choice of number of armature slots in a dc machine.
7. How are induction motor designed for best power factor?
8. What happens if the air gap length of Induction motor is doubled?
9. State the important features of turbo alternator rotor.
10. How to calculate the full load field MMF in synchronous machine?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Briefly Discuss on any five limitations imposed during Electrical Machine Design. (6)

(ii) What is Leakage Flux in Magnetic Circuits? List some leakage fluxes available in the rotating machine. (7)

Or

(b) (i) Mention the properties of Insulating and Conducting materials used in electrical machines. (6)

(ii) Calculate the specific electric and magnetic loading of 100 HP, 300 V, 3 phase, 50 Hz, 8 pole star connected, flame proof induction motor having stator core length = 0.5 and stator bore = 0.66 m. Turns /phase = 286. Assume full load efficiency as 0.938 and pf as 0.86. (7)

12. (a) Estimate the main dimensions including winding conductor area of a 3 = phase, Δ-y core type transformer rated at 300 KVA, 6600/440 V, 50 Hz. A suitable core with 3-steps having a circumscribing circle of 0.25 m diameter and a leg spacing of 0.4 m is available. Emf/turn = 8.5V, δ =2.5 A/mm^2 K_w =0.28, S_f = 0.9. (13)

Or

(b) (i) Starting from the basic EMF equation derivation, Obtain an expression for EMF per turn in terms of output of the transformer. Write a note on factor K. (7)

(ii) Show the steps to estimate the No Load Current of a Three Phase transformer. (6)

13. (a) (i) Explain the procedure for the selection of number of poles in the machine. What are the advantages and disadvantages of large number of poles in a dc machine? (6)

(ii) For a preliminary design of a 40 HP, 230V, 1400 rpm, dc shunt motor. Calculate the armature diameter and core length, the no. of poles and peripheral speed. Take Bav = 0.5 wb/sq.m, ac/m = 25,000, efficiency = 0.9. (7)

Or

(b) Design a suitable commutator for a 350 KW, 600 rpm, 440 V, 6 pole dc generator having an armature diameter of 0.75 m. The number of coils is 288. Assume suitable values wherever necessary. (13)

14. (a) Estimate the stator core dimensions, number of stator slots and number of stator conductors per slot for a 100 kw, 3300v, 50 Hz, 12 pole star connected slip ring induction motor. Assume average gap density = 0.4 wb/m^2; Conductors per metre = 25,000 A/m, efficiency = 0.9, power factor = 0.9 and winding factor = 0.96. Choose main dimensions to give overall design. (13)

Or

(b) (i) Compare: slip ring and cage induction motor from design aspects. (5)

(ii) Design a cage rotor for a 40 HP, 3-phase, 400 V, 50 Hz, 6 pole delta connected IM having a full load efficiency of 87% and a full load pf of 0.85. Take D = 33 cm and L = 17 cm. stator slots = 54, conductors/slot = 14. Assume suitably the missing data of any. (8)

15. (a) (i) Determine the main dimensions of 1000 KVA, 50 Hz, 3 phase, 375 rpm alternator. The average air gap density is 0.55 Wb/m2, ampere conductor/meter 28000. Use rectangular poles, assume ratio of core length to pole pitch as 2. Max permissible peripheral speed is 50 m/sec. The runaway speed = 1.8 times the synchronous speed. Assume winding factor as 0.995. (8)

(ii) Define short circuit ratio in connection with 3 phase synchronous generators. Discuss its effects on the machine performance. (5)

Or

(b) (i) Derive the expression for air gap length in cylindrical rotor machine. (7)

(ii) Give the purpose of providing damper windings in synchronous machines. (6)

PART C — (1 × 15 = 15 marks)

16. (a) (i) What are the different types of materials used in modern electrical machines? (8)

(ii) Compare: conventional DC motor and BLDC motor. (7)

Or

(b) A 1000 KVA, 6600/440V, 3-phase core type transformer has the following design details.

- Distance between centres of adjacent limbs = 0.47m
- Outer dia of HV winding = 0.44 m
- Height of frame = 1.24 m -
- Core loss 3.7 kW and I^2R Loss 10.5 kW

Design a suitable tank for transformer and show the arrangement of cooling tubes.

The average temperature rise is to be limited to 35°C. The diameter of tubes is 50mm and the average height of tubes is 1.4 m. Allow clearance along width as 14 cm, breadth as 18 cm, and height as 60 cm. Specific heat dissipation due to radiation and convection is 6 and 6.5 w/mt²/°c respectively. Assume that convection is improved by 35% due to provision of tubes. (15)

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