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Question Paper Code : 70483

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Sixth Semester

Electrical and Electronics Engineering

EE 6604 – DESIGN OF ELECTRICAL MACHINE

(Regulations 2013)

(Also common to PTEE 6604 – Design of Electrical Machines for B.E. (Part-Time) Fifth Semester – Electrical and Electronics Engineering / Regulation 2014)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Mention the various duty cycles of motor.

2. What are the different conducting materials used in rotating machines?

3. Distinguish between real and apparent flux densities in the tooth section of slot.

4. Write down the expression for brush friction losses.

5. Define Window Space Factor.

6. What are the methods of cooling of transformer?

7. What happens if the air gap length of induction motor is doubled?

8. Name the losses that occur in three-phase induction motors.

9. State the factors for separation of D and L for cylindrical rotor machine.

10. Determine the total number of slots in the stator of an alternator having 4 poles, 3 phase, 6 slots per pole for each phase?

PART B — (5 × 13 = 65 marks)

11. (a) Discuss about the factors that influence the choice of specific electric and magnetic loadings in the design of rotating machines. (13)

Or

(b) Describe the methods of measurements of temperature rise in various parts of an electrical machine. (13)

12. (a) Explain the procedure for the selection of number of poles in dc machine. (13)

Or

(b) For a preliminary design of a 50 HP, 230V, 1400 rpm, dc shunt motor. Calculate the armature diameter and core length, the number of poles and peripheral speed. Take Bav = 0.5 wb/sq.m, ac/m = 25000, Efficiency = 0.9. (13)

13. (a) (i) Differentiate the Design features of power and distribution type transformers. (5)

(ii) Estimate the main dimensions including winding conductor area of a 3-phase, Δ-Y core type transformer rated at 300 kVA, 6600/440V, 50 Hz. A suitable core with 3-steps having a circumscribing circle of 0.25 m diameter and a leg spacing of 0.4m is available. Emf per turn = 8.5 V, $\delta = 2.5 A/mm^2$, $K_w = 0.28$, $S_f = 0.9$. (8)

Or

(b) (i) List and explain the different methods of cooling of transformers. (5)

(ii) The tank of a 500 kVA, 1ϕ, 50 Hz, 6600/400V transformer is 110 cm × 65 cm × 155 cm. If the load loss is 6.2 kW, find and show the suitable arrangements for the cooling tubes to limit the temperature rise to 35°C. Take the diameter of the cooling tubes as 5 cm and average length of the tube as 110 cm. (8)

14. (a) Find the main dimensions, number of radial ventilating ducts, number of stator slots and number of turns per phase of a 3.7 kW, 400 V, 3 phase, 4 pole, 50 Hz, squirrel cage Induction motor to be started by a star delta starter. Work out the winding details. Assume average flux density in the airgap equal to 0.45 wb/m^2, Ampere conductors per meter = 23000, $\eta = 0.85$, power factor = 0.84. Choose main dimensions to achieve cheap design. Winding factor = 0.955, Iron stacking factor = 0.9. (13)

Or

(b) (i) Derive an expression for the endring current in three phase Induction motor. (6)

(ii) A 11 kW, three phase 6 pole, 50 Hz, 220 volts star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the value of bar and end ring currents. The number of rotor bars is 64. The machine has an efficiency of 86 percent and a power factor of 0.85. The rotor MMF may be assumed to be 85 percent of stator MMF. Also find the bar and the end ring sections if the current density is 5 A/mm^2. (7)

15. (a) Determine for a 250 KVA, 1100 V 12 pole, 500 rpm, 3-phase alternator.

- Air gap diameter
- Core length
- Number of stator conductors
- Number of stator slots and
- Cross-section of stator conductors.

Assuming average gap density as 0.6 Wb/m^2 and specific electric loading of 30000 amp. cond/m, $L / \tau = 1.5$. (13)

Or

(b) (i) Mention the factors that govern the design of field system alternator. (5)

(ii) Sketch the shape of salient pole rotor and cylindrical rotor. What are the constructional differences between salient pole type alternator and cylindrical rotor type alternator? (8)

PART C — ($1 \times 15 = 15$ marks)

16. (a) The armature of a 10 pole 1000 kW, 500 V, 300 RPM DC generator has a diameter of 1.6 m. There are 450 coils. Determine suitable length and diameter of the commutator, giving details of brushes having regard to commutation conditions and temperature rise. The design limitations are; peripheral speed of commutator ≤ 20 m/s, pitch of segments ≥ 4, current per brush ≤ 70 A, Temperature rise ≤ 40°C. The other data given are : The brushes span three segments approximately, brush contact drop 1.5 V, coefficient of friction 1.5, brush pressure 20 kN/m^2. Cooling coefficient = $\frac{0.012}{1+0.1V_c}$, Make suitable assumptions for clearance between brushes, staggering of brushes and end play. (15)

Or

(b) (i) Explain the design of damper winding in synchronous machine. (7)

(ii) A 250 kVA, 3 phase, 6600 V salient pole alternator has the following data. Airgap diameter = 1.6 m; length of core = 0.45 m; number of poles = 20; $a_c = 28000$; pole arc to pole pitch ratio = 0.68; stator slot pitch = 28 mm; current density in damper winding = 3 A/mm^2. Design a suitable damper winding for the machine. (8)

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