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Question Paper Code : 11375

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Sixth Semester

Electrical and Electronics Engineering

EE 2355/EE 65 — DESIGN OF ELECTRICAL MACHINES

(Regulation 2008)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the main areas of design of electrical machines.
2. What are the important specifications of a DC machine as per IS 4722:1968?
3. Distinguish between real and apparent flux densities in a DC machine.
4. What are the factors that influence the choice of commutator diameter?
5. Why circular coils are preferred in transformers?
6. What are the factors to be considered for selecting the cooling method of a transformer?
7. How can a 3-phase induction motor be designed for best power factor?
8. Name the different types of leakage fluxes associated with 3-phase induction motors.
9. Define SCR of a synchronous machine.
10. State the important features of turbo-alternator rotors.

PART B — (5 × 16 = 80 marks)

11. (a) (i) State and explain various classes of insulating materials, employed in electrical machines, according to temperature limits. (10)

- (ii) A field coil has a cross section of $100 \times 50 \text{ mm}^2$ and its length of mean turn is 1 m. Estimate the hot spot temperature above that of the outer surface of the coil if the total loss in the coil is 120 W. Assume: Space factor = 0.56. Thermal resistivity of insulating material = $8 \Omega\text{m}$. (6)

Or

- (b) (i) State and explain the general factors that influence the choice of specific electric and magnetic loadings for rotating machines. (12)

- (ii) Explain briefly about the rating of electrical machines. (4)

12. (a) (i) Derive the output equation of a DC machine. (6)

- (ii) Determine the mmf required for the air-gap of a DC machine having open slots, given the following particulars: (10)

Slot pitch = 4.3 cm; Slot opening = 2.1 cm; Gross length of core = 48 cm; Pole arc = 18 cm; Air-gap length = 0.6 cm; Flux per pole = 0.056 weber.

There are 8 ventilating ducts each 1.2 cm wide.

Ratio : $\frac{\text{Slot - opening}}{\text{Gap length}}$	1	2	3	3.5	4.0
Carter's coefficient	0.15	0.28	0.37	0.41	0.43

The above data may be used for ducts also.

Or

- (b) Determine the main dimensions, number of poles and the length of air-gap of a 1000 kW, 500 V, 300 rpm DC generator. Assume average gap density as 0.7 Wb/m^2 and ampere conductors per metre as 40000. The pole arc to pole pitch ratio is 0.7 and the efficiency is 92%. The mmf required for air-gap is 55% of armature mmf and gap contraction factor is 1.15. The following are the design constraints:

Peripheral speed should not exceed 30 m/sec, frequency of flux reversals should not exceed 50 Hz, current per brush arm should not exceed 400 A, and armature mmf per pole should not exceed 10000 A. (16)

13. (a) Calculate approximate overall dimensions for a 200 kVA, 6600/440 V, 50 Hz, 3-phase core type transformer. The following data may be assumed;

emf per 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 a 3-stepped core. For a 3-stepped core, width of largest stamping = $0.9d$ and net iron area = $0.6d^2$; where ' d ' is the diameter of circumscribing circle. (16)

Or

- (b) (i) A single phase, 400 V, 50 Hz, transformer is built from stampings having a relative permeability of 1000. The length of the flux path is 2.5 m, the maximum flux density in the core is 1 Wb/m^2 , the weight of core is 43.8 kg and the primary winding has 800 turns. The iron loss at the working flux density is 2.6 W/kg . Find the no load current of the transformer. (6)
- (ii) Explain the design of transformer tank with cooling tubes. (10)
14. (a) (i) State and explain the factors to be considered when estimating the length of air-gap of a 3-phase induction motor. (10)
- (ii) A 11 kW, 3-phase, 6 pole, 50 Hz, 220 V star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the current in rotor bars. The number of rotor bars is 64. The machine has an efficiency of 0.86 and a power factor of 0.85. The rotor mmf may be assumed as 85% of stator mmf. (6)

Or

- (b) A 15 kW, 400 V, 3-phase, 50 Hz, 6-pole induction motor has a diameter of 0.3 m and the core length of 0.12 m. The number of stator slots is 72 with 20 conductors per slot. The stator is delta connected. Calculate the value of magnetizing current per phase if the length of air-gap is 0.55 m. The gap contraction factor is 1.2. Assume the mmf required for the iron parts to be 35% of the air-gap mmf. Coil span = 11 slots. (16)
15. (a) (i) Find the main dimensions of a 2500 kVA, 187.5 rpm, 50 Hz, 3-phase, 3 kV, salient pole synchronous generator. The generator is to be a vertical, water wheel type. The specific magnetic loading is 0.6 Wb/m^2 and the specific electric loading is 34000 ac/m. Use circular poles with ratio of core length to pole pitch = 0.65. Assume a winding factor of 0.955. (8)
- (ii) State and explain the factors to be considered for the selection of armature slots in an alternator. (8)

Or

- (b) Describe the procedure for the design of field winding of alternator. (16)