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10EE63

Sixth Semester B.E. Degree Examination, Jan./Feb. 2021
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Assume missing data suitably.***
3. ***Design data book may be used, if necessary.***

PART – A

1 a. Discuss the major consideration to evolve a good design. **(05 Marks)**

b. What are the desirable properties of insulating materials? Explain the classification of insulating materials based on thermal considerations. **(08 Marks)**

c. Derive the output equation of D.C machine. What are usual values of specific loadings? **(07 Marks)**

2 a. Find the main dimensions and the number of poles of a 37kW, 230V, 1400rpm, shunt motor so that a square pole face is obtained. The average gap density is 0.5wb/m^2 and the ampere conductors per meter are 22000. The ratios of pole arc to pole pitch is 0.7 and the full load efficiency is 90 percent. **(10 Marks)**

b. Explain the factors to be considered for selection of number of armature slots a dc machine. **(05 Marks)**

c. Determine the number of turns on each commutating pole of a 6 pole machine, if the flux density in the air gap of the commutating pole as 0.5 wb/m^2 at full load and the effective length of air gap is 4mm. The full load current is 500A and the armature is lap wound with 540 conductors. Assume the mmf required for the rest of magnetic circuit to be one tenth that of the air gap. **(05 Marks)**

3 a. Derive an expression for volts/turn of transformer and also give values of constant K for different types of transformer. **(06 Marks)**

b. Why the core of the transformer is stepped? Why the width of central limb of shell type transformer is takes double than that of side limb? **(04 Marks)**

c. Calculate approximate overall dimensions for a 200KVA, 6600/440V, 50Hz, 3 phase core types transformer. The following data may be assumed : emf per turn = 10V ; 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 three stepped core width of largest stamping = 0.9d and Net iron area = 0.6d^2. Where d is the diameter of circumscribing circle. **(10 Marks)**

4 a. Derive an expression for leakage reactance of a transformer with clearly stating the assumption made. **(10 Marks)**

b. A 250KVA, 660/400V, 3 phase core type transformer has total loss of 4800W at full load. The transformer tank is 1.25m in height and 1m × 0.5m is plan. Design a suitable scheme for tubes if the average temperature rise is to be limited to 35°C. The diameter of tubes is 50mm and are spaced 75mm from each other. The average height of tubes is 1.05m. Specific heat dissipation due to radiation and convection is respectively 6 and 6.5 W/m^2°C. Assume that convection is improved by 35 percent due to provision of tubes. **(10 Marks)**

PART – B

5 a. Discuss the factors to be considered for the choice of average flux density in air gap and choice of ampere conductors per meter in the case of induction motor. **(08 Marks)**

b. Determine the main dimension, number of radial ventilating ducts, number of stator slots and number of turns per phase of a 3.7kW, 400V, 3 phases, 4 pole, 50Hz, squirrel cage induction motor to be started by a Star – Delta starter. Assume $B_{av} = 0.45$ wb/m^2, ampere conductors per meter = 23000, efficiency = 0.85, power factor = 0.84, winding factor = 0.955, stacking factor = 0.9. Design is to be carried out for minimum cost. **(12 Marks)**

6 a. Explain the factors to be considered while selecting length of air gap is induction motor. **(10 Marks)**

b. A 15kW, 400V, 3 phase, 50Hz, 6 pole, induction motor has a diameter of 0.3m and the length of core is 0.12m. 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 0.55m. The gap contraction factor is 1.2. Assume the mmf required for the iron parts to be 35 percent of the air gap mmf, Coil span = 11 slots. **(10 Marks)**

7 a. Derive the output equation of a synchronous machine. **(08 Marks)**

b. Find the main dimensions of a 100MVA, 11KV, 50Hz, 150rpm, 3 phase water wheel generator. The average gap density is 0.65 wb/m^2 and ampere conductors per meter are 40,000. The peripheral speed should not exceed 65m/s at normal running speed in order to limit the runaway peripheral speed. **(12 Marks)**

8 a. What is SCR of a synchronous machine? What are the effects of SCR on machine performance? **(10 Marks)**

b. A 500KVA, 3.3KV, 50Hz, 600rpm, 3phase salient pole alternator has 180 turns per phase. Estimate the length of air gap if the average flux density is 0.54wb/m^2, the ratio of pole arc to pole pitch 0.66, the SCR 1.2, the gap contraction factor 1.15, winding factor 0.955. The mmf required for air gap is 80% of no load field mmf and the winding factor 0.955. **(10 Marks)**

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