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10EE63

Sixth Semester B.E. Degree Examination, July/August 2022
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO full questions from each part.***

PART – A

1 a. Discuss briefly about electrical properties of Insulating materials. **(05 Marks)**

b. Make a brief comparison between Copper and Aluminium when used in electrical machines. **(05 Marks)**

c. Find the main dimensions of a 200kW, 250V, 6 pole 1000rpm generator. The maximum value of flux density in the gap is 0.87Wb/m^2 and ampere conductors per metre of armature periphery are 31000. The ratio of pole arc to pole pitch is 0.67, and efficiency is 91%. Assume ratio of core length to pole pitch = 0.75. **(10 Marks)**

2 a. List the factors to be considered for selecting the number of armature slots. What are the guiding factors for the choice of number of armature slots? **(10 Marks)**

b. Determine the total commutator losses for a 800kW 400V, 300rpm, 10pole generator having the following data:
Commutator diameter = 100cm
Current density in brushes = 0.075A/mm^2
Brush pressure = 147kN/m^2
Coefficient of friction = 0.23
Total brush contact drop = 2.2V. **(10 Marks)**

3 a. Explain in brief various types of windings used for the construction of transformer. How the windings are selected based on the conductors cross section? **(08 Marks)**

b. Calculate the approximate overall dimensions for a 200kVA, 6600/440V, 50Hz, 3-ϕ, core type transformer. The following data may be assumed:
emf per turn = 10V; maximum flux density = 1.3Wb/m^2; Current density = 2.5A/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
Net iron area = 0.6d^2
Where d = diameter of circumscribing circle. **(12 Marks)**

4 a. Derive the expression for magnetizing current of transformer in terms of magnetizing VA/kg and weight of the core. Also obtain the expression for no load current of transformer. **(08 Marks)**

b. Design an adequate cooling arrangement for a 250KVA, 6600/400V, 50Hz, 3-phase, Delta/star core type oil immersed natural cooled transformer with the following particulars:

i) Winding temperature rise ≯ 50°C

ii) Total losses at 90°C are 5.0kW

iii) Tank dimensions: Height × length × width = 125 × 100 × 50 (all in cm)

iv) Oil level = 115cm length.

Sketch the diagram to show the arrangement. **(12 Marks)**

PART – B

5 a. Explain the factors affecting choice of average flux density in air gap and ampere conductors per metre in design of induction motors. **(08 Marks)**

b. A 15kW, 440V, 4 pole, 50Hz, 3 phase induction motor is built with a stator bore 0.25m and a core length of 0.16m. The specific electric loading is 23000 ampere conductors per metre. Using the data of this machine, determine the core dimensions, number of stator slots and number of stator conductors for a 11kW, 460V, 6 pole, 50Hz motor. Assume a full load efficiency of 84% and power factor of 0.82 for each machine. The winding factor is 0.955. **(12 Marks)**

6 a. Mention the rules for selecting rotor slots in design of rotor of induction motors. **(05 Marks)**

b. Briefly explain the methods employed for reduction/elimination of harmonic torques. **(05 Marks)**

c. A 75kW, 3000V, 8 pole, 50Hz, 3 phase star connected slip ring induction motor has the following data:
Stator bore = 0.66m; stator core length = 0.50m; number of stator slots = 96; number of rotor slots = 72; number of stator turns per phase = 286; total specific permeance due to stator slots = 4.9μ; no load current per phase = 6.1A; no load power factor = 0.095; harmonic leakage reactance per phase = 0.9Ω.
Estimate the total stand still leakage reactance of motor referred to stator. The winding employs full pitch coils. **(10 Marks)**

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

b. Explain the effect of short circuit ratio on machine performance. **(06 Marks)**

c. Determine the main dimensions for a 1000kVA 50Hz, 3 phase 375rpm alternator. The average air gap flux density is 0.55wb/m^2 and ampere conductors per metre are 28000. Assume winding factor = 0.955, core length to pole pitch ratio = 2 (for rectangular poles). **(06 Marks)**

8 a. A 500KVA, 33KV, 50Hz, 600rpm, 3 phase 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 = 0.65; the short circuit ratio = 1.2; the gap contraction factor = 1.15 and the winding factor = 0.955. The mmf required for gap is 80% of no load field mmf. **(10 Marks)**

b. The field coils of a salient pole alternator are wound with a single layer winding of bare copper strip 30mm deep, with separating insulation 0.15mm thick. Determine a suitable winding length, number of turns and thickness of conductor to develop an mmf of 12000A with a potential difference of 5V per coil and with a loss of 1200W/m^2 of total coil surface. The length of mean turn is 1.2m. The resistivity of copper is 0.021Ω/m-mm^2. **(10 Marks)**

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