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10EE63

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
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 various limitations in electrical machine design. **(06 Marks)**

b. Mention the electrical and mechanical properties required of an insulator. **(06 Marks)**

c. Discuss factors that influence choice of poles in a DC machine. **(08 Marks)**

2 a. Prove that output equation of a DC machine is $W = \frac{30aE_b vq}{pN}$ watts

where a = number of pairs of armature circuit
E_b = average emf induced between commutator segments
v = peripheral velocity
q = ac/m of periphery
p = pole pair and N = rpm

Assume machine is lap wound with single turn coil. **(06 Marks)**

b. Determine the main dimensions of the armature core, number of conductors and commutator segments of a 350kW, 500V, 450rpm, 6-p, shunt generator assuming square pole faces with pole arc = 70% of pole pitch. Assume mean flux density = 0.7T and ac/cm = 280. Take the machine as lap wound with single turn coil. **(07 Marks)**

c. Discuss steps in design of shunt field winding. **(07 Marks)**

3 a. Derive the expression for output equation of a 3-Q core type transformer. **(06 Marks)**

b. Calculate the KVA output of a single-phase transformer from the following data $\frac{\text{Core height}}{\text{distance between core centres}} = 2.8$, $\frac{\text{dia of circumscribing circle}}{\text{distance between core centers}} = 0.56$, $\frac{\text{Net ironarea}}{\text{area of circumscribing circle}} = 0.7$, current density = 2.3A/mm^2, window space factor = 0.27, frequency = 50hz, flux density core = 1.2T, distance between core centers = 0.4m. **(06 Marks)**

c. Determine main dimensions of the core and window of a 500kVA, 6600/400V, 50hz, 1ϕ, core type oil immersed transformer. Assume a flux density of 1.2 wb/m^2, a current density of 2.75 A/mm^2, and window space factor = 0.32, volt/turn = 16.8V. Use cruciform core. The $H_w = 3w_w$. Also find number of turns and conductor cross sectional area for primary and secondary windings. **(08 Marks)**

4 a. Derive an expression for leakage reactance of a core type transformer with concentric winding. State the assumptions made. **(10 Marks)**

b. A 250 KVA, 6600V/400V, 3Q core type transformer has a total loss of 4800W at full load. The transformer tank is 1.25mt in height and 1m × 0.5m in plan. Design a suitable scheme for tubes it average temperature rise is to be limited to 35°C. The diameter of tube is 50mm and are spaced 75mm apart. The average height of tube is 1.05mt. **(10 Marks)**

PART – B

5 a. Derive the output equation of a 3Q induction machine. Discuss effect of specific loadings. **(10 Marks)**

b. A 30HP, 440V, 50hz, induction motor runs at 960rpm. The stator is delta connected. The value of B_{av} = 0.46T and q = 24000 ac/m, full load efficiency = 0.86, power factor = 0.87. Take $L/\tau = 1$. Determine the main dimensions of stator, number of stator slots and stator turns per phase. Take $kw_1 = 0.955$. Take $m_1 = 3$. **(10 Marks)**

6 a. Discuss the various factors considered in the rotor slot selection of a squirrel cage induction machine. **(06 Marks)**

b. A 120 HP, 500V, 50h2, 3Q, 8 pole induction motor has a star connected stator with 63 slots and 6 conductors per slot. If the slip ring voltage on open circuit is around 400V, find a suitable winding for slip ring rotor indicating number of rotor slots, number of rotor conductors/slot, open circuit voltage between slip rings. Take efficiency = 0.9 and pf = 0.86. Also find coil span. Take rotor slots / p / ph = 4. **(08 Marks)**

c. Find magnetizing current for a 15HP, 440V, 6P, delta corrected SRIM with 54 stator slots and 28 conductors per slot. Take flux per pole = 8.25×10^{-3}wb, gap area per pole = 183.5cm^2, air gap length = 0.55mm, carters gap coefficient = 1.33. The ampere turn required for iron parts is approximately 20% of Ampere turn required for air gap. Take $kw_1 = 0.96$. **(06 Marks)**

7 a. What is short circuit ratio? Discuss the effect on performance of synchronous machine. **(10 Marks)**

b. Determine for a 500kVA, 6600V, 12-pole, 500rpm, star- connected salient pole alternator suitable value of diameter, core length, number of stator slots and stator conductors. Take specific electric loading = 30000 ac/m specific magnetic loading = 0.6T, core length = 0.65 * pole pitch. Take winding factor = 0.955. Take stator slots/pole/ phase = 4.0. **(10 Marks)**

8 a. Explain the procedure to design field windings of a synchronous machine. **(08 Marks)**

b. Mention the advantages and disadvantages of having a large airgap in synchronous machines. **(06 Marks)**

c. Estimate air gap length of 500kVA, 3.3 kV, 50hz, 600rpm, 3-Q salient pole alternator with B_{av} = 0.64T, SCR = 1.2, carters gap coefficient = 1.2, 180 turns per phase, $\frac{\text{Pole arc}}{\text{Pole pitch}} = 0.66$. AT_g = 80% of NL AT. Take $kw_1 = 0.955$. **(06 Marks)**

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