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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  $W = \frac{30aE_b v q}{pN}$  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

$$\frac{\text{Core height}}{\text{distance between core centres}} = 2.8, \quad \frac{\text{dia of circumscribing circle}}{\text{distance between core centers}} = 0.56,$$

$$\frac{\text{Net iron area}}{\text{area of circumscribing circle}} = 0.7,$$

current density = 2.3A/mm<sup>2</sup>, 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, 1 $\phi$ , core type oil immersed transformer. Assume a flux density of 1.2 wb/m<sup>2</sup>, a current density of 2.75 A/mm<sup>2</sup>, 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  $\times$  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, 50hz, 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 =  $8.25 \times 10^{-3}$ 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 =  $0.65 \times$  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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