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10EE63

Sixth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. What are the limitations involved, in design of electrical machines? **(06 Marks)**

b. Derive the out-put equation of a D.C. machine. **(06 Marks)**

c. A 350kW, 500V, 450rpm, 6-pole d.c. generator is built with an armature diameter of 0.87m and core-length of 0.32m. The lap wound armature has 660 conductors. Calculate B_{arc} and ac. **(08 Marks)**

2 a. Prove that in a D.C. machine, the volume of active-parts is proportional to torque developed by the machine. **(05 Marks)**

b. State the factors effecting in selecting the value of electric-loading, in case of a D.C. machine. **(05 Marks)**

c. Determine the main dimensions, number of poles and length of air-gap for a 600kW, 500V, 900rpm generator. Assume:
$B_{arc} = 0.6 Wb/m^2$, $(MMF)_{A4} = 50\%$ (MMF)Arm
ac ≠ meter = 35000
$\frac{Pole - Arc}{Pole - Pitch} = 0.75$, efficiency = 91% kg = 1.15. **(10 Marks)**

3 a. Derive the out-put equation of a 3ϕ, core-type transformer. **(06 Marks)**

b. Discuss the factors involved in "optimum design" of a transformer. **(04 Marks)**

c. A 1ϕ, 440V, 50Hz transformer is built in form of stampings having a relative permeability of 1000. The length of the flux-path is 2.5m the area of cross-section of the core is $2.5 \times 10^{-3} m^2$ and the primary wdg has 800 turns. Estimate the max. flux and 'no-load' current of the transformer. Assume: Iron-loss i) working flux density = 2.6 W/kg; ii) Iron wt = 7.8×10^3 kg/m^3; iii) Stacking factor = 0.9. **(10 Marks)**

4 a. Derive an expression for the total leakage reactance of a transformer, reffered to primary. **(10 Marks)**

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

PART – B

5 a. State the factors affecting, length of air-gap in case of a 3ϕ induction motor. **(05 Marks)**

b. Briefly give the design procedure of stator teeth and stator core of a 3ϕ induction motor. **(05 Marks)**

c. Determine the main dimensions, turns/phase, number of slots, conductor cross-section and slot area of a 250HD, 3ϕ, 50Hz, 400V, 1410rpm, slip-ring induction motor. Assume:
   i) $B_{arc} = 0.5$ wb/m^2
   ii) Ac/meter = 30000 A/m
   iii) Efficiency = 0.9
   iv) Power factor = 0.9
   v) Winding factor = 0.955
   vi) Current density = 3.5 A/mm^2
   vii) Slot-space factor = 0.4
   viii) $\frac{\text{Core} - \text{length}}{\text{Pole} - \text{pitch}} = 1.2$.
   Assume Machine Delta connected. **(10 Marks)**

6 a. Discuss briefly the design of 'End-ring' and 'Rotor bar' of a squirrel cage motor. **(08 Marks)**

b. A 11kW, 3ϕ, 6-pole, 50Hz, 220V, Δ- connected induction motor has 54 stator slots, each-containing 9 conductors. Calculate the values of bar and end-ring currents. The number of stator bars is 64. The machine has an efficiency of 0.86 and cosϕ = 0.85. The rotor MMF may be assumed as 85% of stator MMF. Also find the bar and end-ring sections if the current density is 5A/mm^2. **(12 Marks)**

7 a. Discuss the factors affecting choice of magnetic-loading in case of a synchronous machine. **(06 Marks)**

b. Compare round-poles v/s rectangular poles. **(04 Marks)**

c. Determine the main dimensions of 1000KVA, 50Hz, 3ϕ, 375 rpm alternator. The average air-gap density is 0.55 Wb/m^2, ampere conductor per meter is 28000. Use rectangular poles of assume ratio of core length to pole-pitch as 2. Maximum permissible peripheral speed is 50m/s. The run away speed is 1.8 times the synchronous speed. Assume $k_W = 0.955$. **(10 Marks)**

8 a. Define SCR of a synchronous machine. Discuss its effect on performance of the machine. **(06 Marks)**

b. What are steps involved, in design of field windings of a synchronous machine? **(08 Marks)**

c. What are the factors, that effect, selection of armature slots? **(06 Marks)**

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