CBCS SCHEME

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15EE64

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

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Discuss the factors which imposes limitations on design **(08 Marks)**

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

OR

2 a. What are the factors to be considered for design of electrical machines? **(05 Marks)**

b. Classify the soft magnetic materials with examples. **(05 Marks)**

c. What are the properties of high conductivity materials? **(06 Marks)**

Module-2

3 a. Briefly discuss about the factors which influence the selection of number of poles of a DC machine. **(06 Marks)**

b. Derive output equation of a DC machine. **(05 Marks)**

c. A 5KW, 250V, 4 pole, 1500rpm DC shunt generator is designed to have a square pole face. Average flux density in air gap = 0.42 Wb/m^2, specific electric loading = 15000ac/m, full load efficiency = 87% ratio of pole arc to pole pitch = 0.66. Determine the main dimensions of the machine. **(05 Marks)**

OR

4 a. What are the factors to be considered while selecting large number of armature slots for a DC machine? **(06 Marks)**

b. A 440V, 6 pole DC generator has following data mmf per pole = 7000A, depth of winding = 50mm, length of inner turn = 1.1m, length of outer turn = 1.4m, space factor = 0.62, resistivity = 2.1×10^{-8} Ω - m, loss radiated from outer surface excluding ends = $1400W/m^2$ and assume a voltage drop of 20% of terminal voltage across the field regulator. Determine number of turns of each field coil and height of field coil. **(10 Marks)**

Module-3

5 a. Derive output equation of a three phase core type transformer. Obtain relation between emf per turn and KVA per phase of transformer. **(08 Marks)**

b. Determine overall dimensions for a 200KVa, 50Hz, single phase core type transformer from the following data. EMF/turn = 14 volts, maximum flux density = $1.1Wb/m^2$, window space factor = 0.32, current density = $3A/mm^2$, stacking factor = 0.9. A cruciform core is used with distance between core centers = 0.435m. The net iron area is $0.56d^2$ where d is the diameter of circumscribing circle. Width of largest stamping = 0.85d. Assume cruciform section for the Yoke. **(08 Marks)**

OR

6 a. Determine no load current of a single phase 400V, 50Hz transformer from the following data. Length of mean flux path = 2.2m, net iron area = $9 \times 10^{-3}m^2$, primary turns = 200. Joints equivalent to 0.2mm air gap. For a working flux density of $1Wb/m^2$, iron loss is 1.3W/kg and mmf/m = 210A. Iron weighs $7.8 \times 10^3 kg/m^3$. **(08 Marks)**

b. The tank of a natural oil cooled transformer has the dimensions length, width and height as 1m, 0.5m and 1.25m respectively. The full load loss is 4800W. Design a suitable scheme for cooling tubes if the average temperature rise is to be limited to 35°C. The diameter of the tube is 50mm and are spaced 75mm from each other. The average height of the tube is 1.05m. Assume that convection is improved by 35% due to provision of tubes. **(08 Marks)**

Module-4

7 a. Discuss the various factors that influence the choice of length of the air gap of an induction motor. **(07 Marks)**

b. A 40hp, 50Hz, 6pole, 440V, delta connected three phase induction motor has teeth following data. specific magnetic loading = 0.48 Wb/m^2, specific electric loading = 26000 ac/m, ratio of core length to pole pitch = 1, efficiency = 88%, power factor = 0.86. Winding factor = 0.955. Determine the main dimensions, stator turns per phase, number of stator slots and conductors per slot. **(09 Marks)**

OR

8 a. A 11 KW, 6pole, 50Hz 220 voltage star connected three phase induction motor has 54 stator slots with 9 conductors per slot. Calculate values of bar and end ring currents. The number of rotor slots = 64. The machine has an efficiency of 0.86 and a power factor of 0.85. The rotor mmf equals to 85% of stator mmf. Also determine the bar and end ring sections if the current density is $5A/mm^2$. **(08 Marks)**

b. A 15 KW, 400V, 50Hz, 6 pole, three phase induction motor has a diameter of 0.3m and length of core = 0.12m. The number of stator slots is 72 with 20 conductors per slot. The stator is delta connected. Stator winding factor = 0.96. The gap contraction factor is 1.2. Assume the mmf required for the iron parts to be 35% of the air gap mmf. Calculate the value of magnetising current per phase if the length of the air gap is 0.55mm. **(08 Marks)**

Module-5

9 a. Drive the output equation of a synchronous machine. **(08 Marks)**

b. During the design of stator of 7500KVA, 6.6KV, 50Hz, 3000rpm, three phase alternator the following data has been obtained. Stator diameter = 0.75m, core length = 0.9m, number of stator slots/pole/phase = 7. Number of conductors per slot = 4. Winding factor = 0.955 cross sectional area of stator conductor = $190mm^2$. Determine flux per pole, specific magnetic loading, specific electric loading and current density for the stator winding. **(08 Marks)**

OR

10 a. Define short circuit ratio for a synchronous generator. Explain effects of short circuit ratio on synchronous machine performance. **(08 Marks)**

b. A 500KVA, 3.3 KV, 50Hz, 600rpm, three phase salient pole alternator has 180 turns per phase, field form factor = 0.66. Short circuit ratio = 1.2, winding factor = 0.955, gap contraction factor = 1.15. The mmf required for air gap is 80% of no load field mmf. Determine the length of air gap of the average flux density is 0.54 Wb/m^2. **(08 Marks)**

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