CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, June/July 2023
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Explain the design factors to be considered for designing electrical machine. **(08 Marks)**

b. Illustrate the classification of insulating materials based on thermal consideration as per IS 1271 – 1958. Give examples for each class. **(12 Marks)**

OR

2 a. Explain the limitations imposed during electrical machine design. **(10 Marks)**

b. Explain the desirable properties of insulating material used in electrical machines. **(05 Marks)**

c. Explain the types of magnetic materials used in electrical machine. **(05 Marks)**

Module-2

3 a. Derive the output equation of a DC machine. Explain the factors to be considered for the choice of specific loading, while designing DC machine. **(10 Marks)**

b. Determine the main dimensions of the armature core, number of poles, number of commutator segments, number of slots for a 200KW, 300V, 300rpm, DC shunt generator with average flux density as 0.65T, ac/m as 43,000, the ratio of core length to pole pitch is 0.8 and efficiency is 91%. **(10 Marks)**

OR

4 a. Write the advantages of having large number of poles is DC machine. **(06 Marks)**

b. A 5KW, 250V, 4 poles, 1500rpm, shunt generator is designed to have a square pole face. The loading are average flux density = 0.42wb/m^2, AC/m = 15,000. Find the main dimensions of the machine. Assume full load efficiency = 0.87 and ratio of pole arc to pole pitch = 0.66. **(06 Marks)**

c. The outer cylindrical surface of a field coil can dissipate 0.1 watt/cm^2 of its area limited to an axial length of 20cm and as outside of 45cm. If the radial thickness of the coil is cm. Determine the ampere turns that can be accommodated with a terminal voltage of 50V. Take the resistivity of copper as 2 $\mu\Omega$-cm and space factor as 0.6. **(08 Marks)**

Module-3

5 a. Derive expressions for output and emf per turn of a 3-phase are type transformer. **(08 Marks)**

b. Calculate approximate overall dimensions of a 200KVA, 6600/440V, 50Hz, 3-phase are type transfer. The following data may be assumed flux density is 1.3wb/m^2, current density is 2.5A/mm^2 window space factor is 0.3, overall height is equal to overall width, k_i = 0.9, EMF/turn = 10V. Take a = 0.9d, $A_i = 0.6d^2$. Verify overall height is same as that of overall width of the transformer. **(12 Marks)**

OR

6 a. Derive an expression for the leakage reactance of a core type transformer. State clearly the assumptions made. **(10 Marks)**

b. Design the suitable cooling tank for a 500KVA, 6600/440V, 50Hz, 3ϕ core type transformer with the following data. The dimensions of transformer are 100cm height, 96cm length, 47cm width. Total losses = 7KW. Allow a temperature rise for tank wall as 55°C, 5cm diameter tubes are used. Determine the dimensions of the tank, number of tubes required and possible arrangement. **(10 Marks)**

Module-4

7 a. What are the factors to be considered for estimating the length of air gap for induction motor? **(05 Marks)**

b. Derive the output equation for a 3–phase induction motor. **(08 Marks)**

c. Explain the factors to be considered and guidelines for selecting the number of rotor slots. **(07 Marks)**

OR

8 a. Design a rotor for a 3-phase squirrel cage induction motor of 40HP, 50Hz, 6 pole, delta connected, having a full load efficiency of 87% and full load p.f of 0.85. The diameter of stator bore is 0.33m and length is 0.17m with 54 stator slots and 14 conductor per slot. Assume rotor mmf as 0.85 times the stator mmf and length of air gap as $\ell g = 0.2 + 2\sqrt{DL}$ Assume current density as $4A/mm^2$. **(10 Marks)**

b. Design a suitable slip ring rotor for a 400HP, 2000V, 8 pole, 50Hz, 3 – phase, Delta connected induction motor. Take D = 74cm, L = 35 cm, number of stator slots as 96 with 14 conductors per slot. Efficiency = 93% p.f = 0.92. Take $m_2 = 3$ = rotor slots/pole/ph, voltage between slip ring be 600V, star connected. **(10 Marks)**

Module-5

9 a. Derive the output equation of a synchronous machine. Explain the factors to be considered for the choice of specific loading. **(10 Marks)**

b. Determine the diameter and axial length of stator of a 3-phase, 250KVA, 1100 V, 50Hz, 12 pole synchronous generator. Assume specific magnetic loading as $0.6wb/m^2$ and specific electric loading as 30,000 Ac/m. Take the ratio of length to pole pitch as 1.5. Also determine the number of stator conductors, number of stator slots and size of conductor. Assume current density as $3.5A/mm^2$. **(10 Marks)**

OR

10 a. Define short circuit ratio for a synchronous machine. Explain its effect. **(10 Marks)**

b. Calculate the main dimensions of a 1000 KVA, 50Hz, 3 – phase, 375 rpm alternator. The average air gap flux density is $0.55wb/m^2$. AC/m is 28,000. Assume $K_w = 0.955$, ratio of core length to pole pitch as 2. Permitted maximum peripheral speed is 50m/sec. **(10 Marks)**

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