CBCS SCHEME

USN

15EE64

Sixth Semester B.E. Degree Examination, June/July 2019
Electrical Machine Design

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of design data handbook is permitted.
3. Any missing data may be suitably assumed.

Module-1

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

b. What are the desirable properties of magnetic materials? Explain in brief magnetic materials and its classification. **(05 Marks)**

c. Give a brief comparison between copper and aluminium wires. **(05 Marks)**

OR

2 a. Classify the insulating materials used in electrical machines, according to their thermal stability. Give one example for each class. **(06 Marks)**

b. Write brief note on Cold Rolled Grain Oriented (CRGO) steel used in electrical machines. **(05 Marks)**

c. What are the desirable properties of conducting materials? **(05 Marks)**

Module-2

3 a. Define specific electric and magnetic loadings of D.C. machine. What are the merits and demerits of selecting higher values of specific loadings? Mention the factors to be considered during choice of specific loadings. **(08 Marks)**

b. A design is required for a 50kW, 4pole, 600rpm dc shunt generator. The full load terminal voltage is 220V. If the maximum gap density is $0.83 Wb/m^2$ and ampere conductors = 30,000ac/m, calculate suitable dimensions of armature core to give a square pole face. Assume that the full load armature voltage drop is 3% of rated terminal voltage and field current is 1% of rated full load current. The ratio of pole arc to pole pitch is 0.67. **(08 Marks)**

OR

4 a. Discuss the various factors which govern the choice of number of poles in a D.C. machine. **(08 Marks)**

b. A shunt field coil has to develop an mmf of 9000A. The voltage drop in the coil is 40V and the resistivity of the round wire is $0.021 \Omega/m/mm^2$. The depth of the winding is 35mm approximately and the length of the mean turn is 1.4m. Design a coil so that the power dissipated is $700 W/m^2$ of the total coil surface. Take diameter of the insulated wire 0.2mm greater than the bare wire. **(08 Marks)**

Module-3

5 a. Derive the output equation of a 3 phase core type transformer and hence deduce an expression for output-emf/turn. **(08 Marks)**

b. Calculate the main dimensions and winding details of a 100kVA, 2000/400V, 50Hz, 1ϕ shell type, oil immersed self cooled transformer. Assume voltage per turn = 10V, flux density in core = $1.1 Wb/m^2$, current density = $2A/mm^2$, window space factor = 0.33, the ratio of window height to window width is 3, ratio of core depth to width of central limb = 2.5, stacking factor = 0.9. **(08 Marks)**

OR

6 a. Explain the procedure to calculate the no-load current for a single phase transformer. **(08 Marks)**

b. A 250kVA, 6600/400V, 3ϕ core type transformer has a total loss of 4800W at full load. The transformer tank is 1.25m in height and 1m × 0.5m in plan. Design a suitable scale for number of tubes, if the average temperature rise is 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. Specific heat dissipation due to radiation and convection is respectively 6 and 6.5 W/m^2 °C. Assume convention is improved by 35% due to provision of tubes. **(08 Marks)**

Module-4

7 a. With usual notations, derive the output equations of a 3ϕ induction machine. **(08 Marks)**

b. Calculate the diameter of stator bore and core length of a 70HP, 415V, 3ϕ, 50Hz, Y connected, 6 pole Induction motor for which q = 32000 Ac/m, B_{av} = 0.51 T, efficiency = 90%, p.f. = 0.91. Assume pole pitch equal to core length. Estimate the number of stator conductors required for a winding in which the conductors are connected in two parallel paths. Choose a suitable number of conductors/slot, so that the slot loading does not exceed 750 Ampere conductors. **(08 Marks)**

OR

8 a. Discuss the factors to be considered while deciding the length of air gap, number of stator and rotor slots in an Induction motor. **(08 Marks)**

b. A 15kW, 3ϕ, 6 pole, 50Hz, squirrel cage Induction motor has the following data: stator bore dia = 0.32m, axial length of stator core = 0.125m, number of stator slots = 54, number of conductors/stator slot = 24, current in each stator conductor = 17.5A, full load power factor = 0.85 lagging. Design a suitable cage rotor giving number of rotor slots, section of each bar, section of each ring. The full load speed is to be 950rpm approximately. Use copper for rotor bars and end rings. Resistivity of copper = 0.02Ω/m and mm^2. Assume δ = 7A/mm^2 for end rings. **(08 Marks)**

Module-5

9 a. Derive an output equation of a synchronous machine and show that $HP = \dfrac{\text{Input KVA} \times \eta \times \cos\phi}{0.746}$. **(08 Marks)**

b. A 1000KVA, 3300V, 50Hz, 300rpm, 3ϕ alternator has 180 slots with 5 conductors/slot, single layer winding with full pitch coils is used. The winding is star connected with one circuit per phase. Determine the specific electric and specific magnetic loadings, if the stator bore is 2.0m and the core length is 0.4m. Using the same loadings, determine corresponding data for a 1250kVA, 3300V, 50Hz, 250rpm, 3ϕ star connected alternator having 2 circuits per phase. The machines have 60° phase spread. **(08 Marks)**

OR

10 a. What is SCR of a synchronous machine? What are the effects of SCR on machine performance? **(08 Marks)**

b. A 2500kVA, 225rpm, 3ϕ, 60Hz, 2400V, Y-connected salient pole alternator has the following design data: stator bore = 2.5m, core length = 0.44m, slot/pole/phase = 3, conductors/slot = 4, circuits/phase = 2, leakage factor = 1.2, winding factor = 0.95.
The flux density in the pole core is 1.5 Wb/m^2, the winding depth is 30mm, the ratio of full load field mmf to armature mmf is 2, field winding space factor is 0.84 and the field winding dissipates 1800 W/m^2 of inner and outer surface without the temperature rise exceeding permissible limit. Leave 30mm for insulation, flanges and height of pole shoe along the height of pole. Find: i) The flux per pole ii) Length and width of pole iii) Winding height iv) Pole height. **(08 Marks)**

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