CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, July/August 2022
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Assume any missing data suitably.

Module-1

1 a. Explain the principle of electrical machine design. What are the limitations in the design? **(10 Marks)**

b. List the desirable properties of insulating materials. Explain the classification of insulating materials based on thermal consideration. **(10 Marks)**

OR

2 a. Explain in brief magnetic materials, characteristics and application of sheet steels. **(10 Marks)**

b. List out the desirable properties of conducting materials. Distinguish between aluminium and copper wires. **(10 Marks)**

Module-2

3 a. Explain in brief the factors to be consider during for the choice of specific electric loading. **(05 Marks)**

b. Justify the statement the total weight of iron part in d.c machines decreases with increase in number of poles. **(08 Marks)**

c. A 125watt, 230volts, 500rpm motor has a full load efficiency of 50 percent. Calculate constant loss and power developed by the armature of the motor if the sum of iron, friction and windage loss is approximately 1/3 of total losses. **(07 Marks)**

OR

4 a. Explain the guiding factors for choice of number armature slots in d.c. machines. **(08 Marks)**

b. The field coils (cylindrical) of a 4-pole, d.c. shunt motor are required to be produced an mmf of 5700A per pole. The length of mean turn is 0.66 and the winding depth is 40mm. Heat dissipated at the rate of $1000w/m^2$ of the outside cylindrical surface of the coil. Determine dimensions of coil, size of conductor and number field coil turns. Assume diameter of insulated conductor to be 0.175 meter greater than the diameter of base conductor. Resistivity = $0.02\Omega/m/mm^2$. **(12 Marks)**

Module-3

5 a. Prove that emf per turn of a single phase transformer is equal to $K\sqrt{Q}$ where Q = KVA per phase. List the factors on which the value of K depends. **(08 Marks)**

b. Show that the ratio of gross core area to area of circumscribing circle in a two stepped core of a transformer is 0.79. **(07 Marks)**

c. A 3-ϕ, 50Hz core type transformer has the following dimensions distance between core centre = 0.2m, height of window = 0.24m, diameter of circumscribing circle = 0.14m, the flux density in the core = $1.25Wb/m^2$ and current density in the conductor is $2.5A/mm^2$. Estimate the KVA rating. Assume window space factor is equal to 0.2 and core area factor = 0.56. The core is two-stepped. **(05 Marks)**

OR

6 a. Derive an expression for leakage reactance of a transformer with primary and secondary cylindrical coils of equal length, stating clearly the assumptions made. **(10 Marks)**

b. A 250KVA, 6600/440V, 50c/s, 3-ϕ, Y/Δ core type transformer gave the following results during the design calculations. Length core plus twice the height of the yoke = 85cm, centre-to-centre distance of the core = 32cm, outer diameter of HV winding = 31cm, total iron loss = 1500 watts cu loss in LV winding = 1200 watts, cu loss in HV winding = 2050 watts. Calculate:

i) Dimension of the transformer tank.
ii) Temperature rise of transformer.
iii) Number of cooling tubes if the temperature rise is not to exceed 35°C.

Assume the clearance at the base and top = 500mm
Clearances length wise = 10mm
Clearances along width wise = 15mm
Length of cooling tube = 1.35m
Diameter of tube = 50mm. **(10 Marks)**

Module-4

7 a. Mention the factors that influence the choice specific loadings. **(06 Marks)**

b. Mention different L/τ values used in the design of induction motors. **(04 Marks)**

c. Find the values of diameter and length of stator core of a 7.5kW, 220V, 50Hz, 4-pole, 3-phase I.M for best power factor. Given: specific magnetic loading = 0.4wb/m^2; specific electric loading = 22000Ac/m; efficiency = 0.86 and p.f = 0.87. Also find the main dimensions if the ratio of core length of pole pitch is unity. **(10 Marks)**

OR

8 a. List out the factors that affects the length of air gap. **(04 Marks)**

b. Write different equations to estimate the length of air gap of an induction motor. **(04 Marks)**

c. A 415V, 3-phase, 50Hz, 6-pole delta connected induction motor has a specific magnetic loading of 0.5Wb/m^2 and a specific electric loading of 24000A/m. The stator core diameter and length are 0.275m and 0.15m respectively. Find the output of the machine if the full load efficiency and power factor are 0.88 and 0.89 respectively. Determine the number of slots conductors per slots and length of air gap. **(12 Marks)**

Module-5

9 a. From first principles derive the output equation of a synchronous machine. **(08 Marks)**

b. Write down the factors to be consider for the selection of armature slots. **(04 Marks)**

c. A 500KVA, 3.3KV, 50Hz, 600rpm, 3-ϕ, salient pole alternator has 180 turns per phase. Estimate the length of air gap if the average flux density is 0.54Wb/m^2. The ratio of pole arc to pole pitch is equal to 0.66, the short circuit ratio = 1.2 and the gap extension co-efficient = 1.15. The mmf required for the air gap is 80% of no load field mmf winding factor = 0.955. **(08 Marks)**

OR

10 a. Explain the term short circuit ratio as applied in synchronous machine and explain its effect on machine performance. **(10 Marks)**

b. The field coil of salient pole alternator are wound with a single layer winding of bare cu strip 30mm deep, with separating insulation 0.15mm thick. Determine a suitable value of winding length, number of turns and thickness of conductor to develop an mmf of 12000A with a potential difference of 5V per coil and with a loss of 1200w/m^2 of total coil surface. The mean length of turn is 1.2m. The resistivity of cu is 0.21Ω/m and mm^2. **(10 Marks)**

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