CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, June/July 2024
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

Note: **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Design data handbook is allowed if necessary.***

Module-1

1 a. Discuss the design factors to be considered for electrical machine. **(06 Marks)**

b. Explain briefly on limitations imposed during Electrical Machine Design. **(08 Marks)**

c. Write a note on modern trends in machine design and manufacturing techniques. **(06 Marks)**

OR

2 a. Mention any five desirable properties of insulating and conducting materials used in electrical machines. **(10 Marks)**

b. Discuss the classification of insulating material based on heat resisting properties mentioning with any two examples of each type. **(10 Marks)**

Module-2

3 a. Define specific magnetic loading and specific electric loading for a DC machine. **(04 Marks)**

b. Derive the output equation of DC Machine. **(06 Marks)**

c. A 5 KW, 250V, 4 pole, 1500 rpm, wave winding connected, DC shunt generator is designed to have a square pole face. The loadings are average flux density in the gap = 0.42 wb/mt^2 and ampere conductor per meter = 15000. The ratio of pole arc to pole pitch is 0.66 and efficiency is 87%. Find the main dimensions of the machine. Verify:
(i) Peripheral speed of armature is within the limit of 30 m/sec
(ii) Voltage between adjacent commutator segments is within 20 V. **(10 Marks)**

OR

4 a. Discuss the factors to be considered for selection of number of poles, in detail. **(10 Marks)**

b. Design a 4 pole, 10 KW, 220 V, 1000 rpm DC shunt motor with respect to the following:
(i) Output coefficient
(ii) The diameter and length of armature
(iii) Number of armature conductors
(iv) Number of slots
Assume, specific magnetic loading = 0.45 wb/mt^2, specific electric loading = 17500 ac/m; efficiency = 91%; pole arc/pole pitch = 0.68; 10% voltage drop in armature winding. **(10 Marks)**

Module-3

5 a. Starting from the basic emf equation derivation, obtain an expression for emf per turn in terms of output of the transformer. Write a note on factor 'K'. **(08 Marks)**

b. Determine the main dimensions of the core, the number of turns and the cross section of the conductors for a 5 kVA, 11000/400 V, 50 Hz, single phase core type distribution transformer. The net conductor area in the window is 0.6 times the net cross section of iron in the core. Assume a square cross-section for the core, flux density of 1 wb/mt^2, a current density of 1.4 A/mm^2 and a window space factor 0.2. The height of window is 3 times its width. **(12 Marks)**

OR

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

b. A 1000 KVA, 6600/440 V, 3-phase core type transformer has the following design details:

(i) Distance between centre's of adjacent limbs = 0.47 m
(ii) Outer dia of HV winding = 0.44 m
(iii) Height of frame = 1.24 m
(iv) Core loss = 3.7 KW
(v) I^2R loss = 10.5 KW

Design a suitable tank for transformer and number of cooling tubes. The average temperature rise is to be limited to 35°C. The diameter of tubes is 50 mm and the average height of tubes is 1.4 m. Allow clearance along width as 14 cm, breadth as 18 cm and height as 60 cm. Assume specific heat dissipation due to radiation and convection is 6 and 6.5 W/mt^2/°C respectively. Convection is improved by 35% due to provision of tubes. **(10 Marks)**

Module-4

7 a. With usual notations derive output equation for a three phase induction motor. **(06 Marks)**

b. Write the advantages and disadvantages of choosing higher value of specific loadings. **(06 Marks)**

c. Find the main dimensions of a 15 KW, 3-ϕ, 400 V, 50 Hz, 2810 rpm, squirrel cage induction motor having an efficiency of 0.88 and full load p.f. of 0.9. Take the rotor peripheral speed as 20 m/sec at synchronous speed. Assume specific magnetic loading as 0.5 wb/mt^2 and specific electric loading as 25000 ac/m. **(08 Marks)**

OR

8 a. Discuss the factors to be considered while deciding the length of air gap and number of stator slots. **(10 Marks)**

b. A 15 KW, 440 V, 4-pole, 50 Hz, 3-ϕ IM is built with a stator bore 0.25 m and a core length of 0.16. The specific electric loading is 23000 ac/m. Using the data of this machine, determine the core dimensions, number of stator slots and number of stator conductors for a 11 KW, 460 V, 6 poles, 50 Hz motor. Assume a full load efficiency of 84% and p.f. of 0.82 for each machine. The winding factor is 0.955. Slots per pole per phase = 3. **(10 Marks)**

Module-5

9 a. Define SCR and list advantages and disadvantages of choosing low value of SCR. **(10 Marks)**

b. Determine the main dimensions for a 1000 KVA 50 Hz, 3-ϕ, 375 rpm alternator. The average air gap flux density is 0.55 wb/mt^2 and ac/m are 28000. Use rectangular poles and assume a suitable value for ratio of core length to pole pitch as 2 and maximum peripheral speed permissible is 50 m/sec. The runaway speed is 1.8 times the synchronous speed. $K_W = 0.995$. **(10 Marks)**

OR

10 a. Discuss the factors which influence the selection of armature slots of synchronous machine. **(10 Marks)**

b. Determine a suitable number of slots and conductors per slot for the stator winding of a 3-ϕ, 3300 V, 50 Hz, 300 rpm alternator. The diameter is 2.3 m and the axial length of core is 0.35 m. The maximum flux density in the air gap should be approximately 0.9 wb/mt^2. Assume sinusoidal flux distribution. Use single layer winding and star connection for stator. **(10 Marks)**

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