CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, Feb./Mar.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. What are the important considerations for the design of electrical machines? Explain in brief and what are its limitations? **(10 Marks)**

b. Mention the desirable properties of electrical insulating materials. Also give the classification of insulating material based on temperature with an example for each. **(10 Marks)**

OR

2 a. What are the desirable properties of magnetic materials? Explain in brief magnetic material and its classification. **(10 Marks)**

b. Write brief note on modern manufacturing techniques in the design of electrical machines. **(10 Marks)**

Module-2

3 a. Discuss the various factors which govern the choice of number of poles in a DC machine. And what are the advantages of choosing larger number of poles. **(10 Marks)**

b. Calculate the diameter and length of armature for a 7.5 kW, 4 pole, 1000 rpm, 220 V shunt motor. Given : Full load efficiency 83%, Maximum gap flux density = 0.9 wb/m^2; Specific electric loading = 30000 ampere conduction per metre ; field form factor = 0.7. Assume that the maximum efficiency occurs at full load and the field current is 2.5% of rated current. The pole face is square. **(10 Marks)**

OR

4 a. The following particulars refer to the shunt field coil for a 440 V, 6 pole, DC generator : MMF per pole = 7000 A, Depth of winding = 50 mm, Length of inner turn = 1.1 m; Length of outer turn = 1.4 m, Loss radiated from outer surface excluding ends = 1400 W/m^2, Space factor = 0.62 ; Resistivity = 0.02 Ω/m and mm^2. Calculate

(i) The diameter of the wire (ii) Length of coil
(iii) Number of turns and (iv) Exciting current **(10 Marks)**

b. Define specific electric and magnetic loadings of a DC machines. What are the merits and demerits of selecting higher value of specific loadings? Mention the factors to be consider during the choice of specific loading. **(10 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. **(10 Marks)**

b. Determine the dimension of core and yoke for a 200 KVA, 50 Hz single phase core type transformer. A cruciform core is used with distance between adjacent limbs equal to 1.6 times the width of core laminations. Assume voltage per turn 14 V, maximum flux density 1.1 wb/m^2, windows space factor 0.32, current density 3 A/mm^2 and stacking factor = 0.9. The net iron area is 0.56 d^2 in a cruiciform core where d is diameter of circumscribing circle. Also the width of largest stamping is 0.85 d. **(10 Marks)**

OR

6 a. Explain the procedure to calculate the no load current for a single phase transformer. **(10 Marks)**

b. A 250 KVA, 6600/400 V, 3 phase core type transformer has a total loss of 4800 W at full load. The transformer tanks is 1.25 m in height and 1m × 0.5m in plan. Design a suitable scheme for tubes if the average temperature rise is to be limited to 35°C. The diameter of tubes is 50 mm and are spaced 75 mm from each other. The average height of tubes is 1.05 m. Specific heat dissipation due to radiation and convection is respectively 6 and 6.5 W/m^2 - °C. Assume that convection is improved by 35 percent due to provision of tubes. **(10 Marks)**

Module-4

7 a. Derive expression for rotor bar and end ring current of squirrel cage induction motor. **(10 Marks)**

b. Find the main dimension of a 15 kW, 3 phase, 400 V, 50 Hz, 2810 rpm squirrel cage induction motor having an efficiency of 0.88 and a full load power factor of 0.9.
Assume :
Specific magnetic loading = 0.5 wb/m^2
Specific electric loading = 25000 A/m
Take the rotor peripheral speed as approximately 20 m/s at synchronous speed. **(10 Marks)**

OR

8 a. With usual notations, derive the output equations of a 3 phase induction machine. **(10 Marks)**

b. Discuss the factors to be considered while deciding the length of air gap, number of stator and rotor slots in an induction motor. **(10 Marks)**

Module-5

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

b. Determine the main dimensions for a 1000 KVA, 50 Hz, 3 phase, 375 rpm alternator. The average air gap flux density is 0.55 wb/m^2 and the ampere conductors per meter are 28000. Use rectangular poles and assume a suitable value for ratio of core length of pole pitch in order that bolted on pole construction is used for which the maximum permissible peripheral speed is 50 m/s. The runaway speed is 1.8 times the synchronous speed. **(10 Marks)**

OR

10 a. The fields coils of a salient pole alternator are wound with a single layer winding of bare copper strip 30 mm deep, with separating insulation 0.15 mm thick. Determine a suitable winding length, number of turns and thickness of conductor to develop an mmf of 12000 A with a potential difference of 5 V per coil and with a loss of 1200 W/m^2 of total coil surface. The mean length of turn is 1.2 m. The resistivity of copper is 0.021 Ω/m and mm^2 **(10 Marks)**

b. Explain the factors to be considered in the selection of number of armature slots of a synchronous machine. **(10 Marks)**

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