2002 SCHEME

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EE62

Sixth Semester B.E. Degree Examination, Dec.09/Jan.10
Electrical Machines Design

Time: 3 hrs. Max. Marks:100

Note:1. ***Answer any FIVE full questions.***
2. Any missing data may be suitably assumed.

1 a. What are the major considerations to evolve a good design? Briefly explain them. **(06 Marks)**
b. Classify the magnetic materials in accordance with the value of their relative permeability. Give one example for each type. **(04 Marks)**
c. What are the recognized classes of insulating materials and the temperature assigned to them? Mention at least two examples for each type. **(10 Marks)**

2 a. Define specific loadings. Discuss the factors which influence the choice of specific electric loading in d.c. machines. **(06 Marks)**
b. Prove that in a d.c. machine the volume of active parts is proportional to torque of the machine. **(06 Marks)**
c. Find the main dimensions and number of poles of a 50 h.p., 230 V, 1400 rpm shunt motor so that a square pole face is obtained. B_{av} in the gap is 0.5 wb/m^2 and the ampere-conductors per meter are 22000. The ratio of pole arc to pole pitch is 0.7. Assume the efficiency of the machine is 90%. Check the obtained values are within the permissible limits. **(08 Marks)**

3 a. Discuss the guiding factors for the choice of number of armature slots in a dc machine. **(05 Marks)**
b. Draw a neat sketch of four pole dc machine indicating the magnetic circuit and different parts involved in it. Also explain with suitable expressions to estimate the total mmf per pole at no load and normal voltage. **(08 Marks)**
c. Design a shunt field coil of a dc motor from the following data:
Field ampere-turns per pole = 9000
Mean length of turn = 1.4 m
Depth of coil = 35×10^{-3} m
Voltage across field coil = 40 V
Resistivity of the wire = 2.1×10^{-8} Ω-m
Thickness of insulating varnish = 0.2 mm
Power dissipation from total surface of the coil should not exceed 700 W/m^2. Check your design for power dissipation. Take the copper space factor for field coil as 0.65. **(07 Marks)**

4 a. For a transformer, show that the emf per turn Et is given by, Et = $K\sqrt{KVA}$, where K is a constant and KVA is the rating of the transformer. What are the factors on which the value of K depends? **(06 Marks)**
b. Show that the ratio of net core area to area of circumscribing circle in a 2-stepped core of a transformer is 0.71. **(04 Marks)**
c. Determine the dimensions of the core and yoke for a 100 KVA, 50 Hz, 1-phase, core type transformer. A square core is used with distance between the adjacent limbs equal to 1.6 times the width of the laminations. Assume voltage per turn of 14 V, maximum flux density 1.1 Wb/m^2, window space factor 0.32 and the current density 3 A/mm^2. Take the stacking factor = 0.9. Flux density in the yoke to be 80% of flux density in core. **(10 Marks)**

5 a. Deduce the output equation of a 3-phase induction motor in terms of its specific loads, speed etc. Explain the factors to be considered during the choice of specific electric and specific magnetic loading. **(10 Marks)**

b. With suitable equations, explain the design of stator core of a 3-phase induction motor. **(04 Marks)**

c. Find the main dimensions 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 p.f. of 0.9. Assume : Specific magnetic loading = 0.5 wb/m^2 ; Specific electric loading = 2500 A/m. Take the rotor peripheral speed as approximately 20 m/s at synchronous speed. **(06 Marks)**

6 a. How to determine the no-load current in a 3-phase induction motor? Explain the procedure to calculate the magnetizing current in the three phase induction motor. **(12 Marks)**

b. A 5 HP, 4 pole, 3-phase induction motor works on a 50 Hz, 400 V mains. It is designed for star-delta starting and has the following design data: Rotor diameter = 14 cm; Gross core length = 11.5 cm; Turns per phase on the stator = 360; Air gap length = 0.4 mm; Winding factor = 0.955; Iron factor = 0.95; Gap contraction co-efficient = 1.25. Assuming that the ampere-turns required for the iron parts are about 30% of that required for the gap, calculate the magnetizing current. **(08 Marks)**

7 a. Mention the normal values of specific magnetic loading and specific electric loadings while designing for salient pole machines and turbo-alternators. **(04 Marks)**

b. Explain the procedure for the design of the field winding of a 3-phase hydro-generator. **(08 Marks)**

c. Determine the main dimensions for 1 MVA, 50 Hz, 3-phase, 6.25 rps alternator. The average air gap flux density is 0.55 wb/m^2 and the ampere-conductors per meter are 28000. Use rectangular poles. The length of the core is twice the pole pitch in order that bolted on pole construction is used for which the maximum permissible peripheral speed is 50 m/s. The run away speed is 1.8 times the synchronous speed. Assume the winding factor as 0.955. **(08 Marks)**

8 Write short notes on the following:

a. Basic circuits in rotating electrical machines.

b. Transformer tank design.

c. Current distribution in squirrel cage rotors.

d. Shaded pole type I-phase induction motor. **(20 Marks)**

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