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10EE63

Sixth Semester B.E. Degree Examination, July/August 2021
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Missing data, if any, may be suitably assumed.

1 a. What are the factors those limit the design of an electrical machine? Explain. **(08 Marks)**

b. With usual notations derive the output equation of a DC machine. **(05 Marks)**

c. Calculate the diameter and length of armature core for a small rating machine of 7.5KW; 4-pole; 1000rpm; 220V DC shunt motor. Give full load efficiency = 0.83; maximum flux density = 0.9Wb/m^2; specific electric loading = 30,000; field form factor = 0.7. Assume the pole face as square one. **(07 Marks)**

2 a. Discuss the factors which govern the choice of number of poles in DC machines. **(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 round wire used is 0.021Ω/m and mm^2. The depth of winding is 35mm, and the length of mean turn is 1.4m. Design a coil so that the power dissipated is 70W/m^2 of the total coil surface (in outer, inner, top and bottom). Take the diameter of insulated wire as 0.2mm more than that of the base wire. **(12 Marks)**

3 a. Derive the output equation of 3-phase are type transformer. **(05 Marks)**

b. Show that the ratio of net are area to area of circumscribing circle in a cruciform core is 0.71. **(05 Marks)**

c. Determine the main dimension of the 3 steeped core; the number of turns and their cross sectional are as of conductors in the primary and secondary windings of a 100KVA; 2200/480V single phase core type transformer to operate at a frequency of 50Hz. Assume the following data voltage per turn = 7.5V; maximum flux density = 1.2Wb/m^2; ratio of effective cross sectional area of core to the square of diameter of the circumscribing circle = 0.6; ratio of height to width of the window = 2; window space factor = 0.28 and current density = 2.5A/mm^2. **(10 Marks)**

4 a. Calculate the no load current of a 400V; 50Hz single phase core type transformer for the following data :
Length of mean magnetic path = 200cm
Gross core section = 100cm^2
Joints equivalent to 0.1mm of air gap
Maximum flux density = 0.7T
Specific core loss at 50Hz and 0.7T are 0.5W/kg
Ampere turns/m = 220
Stacking factor = 0.9
Density of core material = 7.5×10^3kg/m^3. **(10 Marks)**

b. Design an adequate cooling arrangement for a 250 KVA; 6600/400V; 50Hz ; 3-phase delta/star core type oil immersed and natural cooled transformer with the following particulars :
Total loses are = 5.0KW ; θ = 50°C and λ = 12.5w/m^2/°C
Tank dimensions = (125 × 100 × 50)cm
Oil level = 105cm length
Diameter of tubes = 50mm
Clearances widthwise on either side = 60mm
Clearances lengthwise on either side = 35mm
Sketch the diagram to show the tube arrangement. **(10 Marks)**

5 a. Discuss the various factors that influence the choice of length air gap and an induction motor. **(10 Marks)**

b. Calculate :

i) Stator core dimensions
ii) No of turns per phase
iii) Cross section of stator conductor
iv) Total copper loss in stator.

of a 3-phase; 120KW; 2200V; 50Hz; 750rpm (synchronous); star connected slip ring induction motor for the following data :

B_{av} = 0.48T; ac = 26000A/m; efficiency = 92%; power factor = 0.88; L/τ = 1.25; K_{ws} = 0.955 current density = 5A/mm^2; mean length of stator conductors = 75cm; $\rho = 0.021\Omega$/m-mm^2. **(10 Marks)**

6 a. A 15KW; 400V; 3-phase; 50Hz; 6 pole induction motor has a diameter of 0.3m and the length of core 0.12m. The number of stator slots are 72 with 20 conductors per slot. The stator is delta connected. Calculate the value of magnetizing current per phase if the length of air gap is 0.55m. The gap contraction factor is 1.2. Assume the mmf required for the iron parts to be 35% of air gap mmf and winding factor as 0.955. **(10 Marks)**

b. A 11KW; 3-phase; 6-pole; 50Hz; 220V star connected induction motor has 54 stator slots each containing of conductors. The number of rotor bars are 64. The machine has an efficiency of 0.86 and power factor 0.85. The rotor mmf may be assumed as 85% of stator mmf. Calculate the :

i) Values of bar and end ring currents
ii) Bar and end ring sections if current density is 5A/mm^2
iii) Rotor copper loss if resistance of each bar is 125$\mu\Omega$. **(10 Marks)**

7 a. Define Short Circuit Ratio(SCR) of a synchronous machine and explain its effects on the machine performance. **(10 Marks)**

b. A 500KVA; 3.3KV; 50Hz; 600rpm; 3-phase star connected 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 are to pole pitch is 0.65; the short circuit ratio = 1.2; the gap contraction factor 1.15 and the winding factor = 0.955. The mmf required for the gap is 80% of no load field mmf. **(10 Marks)**

8 a. Deduce from first principles the output equation of synchronous machine. **(06 Marks)**

b. Briefly explain the factors to be considered while selecting armature slots in synchronous machines. **(08 Marks)**

c. Find the main dimensions of a 100MVA; 11KV; 50Hz; 150rpm; 3-phase water wheel generator. The average gap density is 0.65Wb/m^2 specific electric loading = 40,000. The peripheral speed should not exceed 65m/sec at normal running speed in order to limit the runaway speed. Given $\frac{L}{\tau} = 4$ winding factor = 0.955. **(06 Marks)**

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