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EE62

Sixth Semester B.E. Degree Examination, June / July 08

Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note : ***Answer any FIVE full questions.***

1 a. What are the major considerations to be accounted for the good design of electrical machines? **(05 Marks)**

b. Enumerate the required properties of the magnetic materials used for the manufacture of electric machines. **(05 Marks)**

c. List any four insulating materials used in electrical machines specifying their thermal class. **(04 Marks)**

d. Derive the output equation of D.C. machine. **(06 Marks)**

2 a. Discuss the various factors which govern the choice of number of poles in D. C. machines. **(10 Marks)**

b. Determine the main dimensions; best number of poles; length of air gap for a 600 kW; 500 V; 900 rpm DC generator. Assume the average gap density as 0.60 ub /m^2 and ampere conductor loading 35,000. The ratio of pole arc to pole pitch is 0.75 and the efficiency is 91%. The peripheral speed is to be below 40 m /sec and the armature mmf per pole to be below 7500 A. The mmf required for air gap is 50% of armature mmf; Gap contraction factor = 1.15. **(10 Marks)**

3 a. Show that –

i) For minimum cost design of transformer, cost of iron = cost of conductor

ii) For minimum copper loss current density in primary winding = current density in secondary winding. **(10 Marks)**

b. A 250 KVA 6600 /440 V; 50 c/s; 3 phase, star /delta core type oil immersed natural cooled transformer gave the following results during the design calculations. Length of the core plus twice the height of the yoke = 85 cm
centre to center distance of the core = 32 cm
outside diameter of the HV winding = 31 cm
total iron losses = 1500 watts
copper losses in the LV winding = 1200 watts
copper losses in the HV winding = 2050 watts

Calculate :

i) The dimensions of the tank

ii) Temperature rise of the transformer

iii) Number of tubes if the temp rise is not to exceed 35^0 C

Assume clearances at the base and top = 500 mm
clearances lengthwise = 10 mm
clearances along width wise = 15 mm.
Length of cooling tube = 1.35 m, diameter of tube = 50 mm. **(10 Marks)**

4 a. Derive an expression for the no load current of a 3 –phase transformer. **(05 Marks)**

b. Show that for a stepped core

$$\text{Ratio} \frac{\text{Net core area}}{\text{Area of circum scribing circle}} = 0.71.$$ **(07 Marks)**

c. The window of a 50 KVA; 1 – phase, core type transformer has an area of 340 cm^2. The window space factor is 0.35; maximum flux density in the core is 1.0 Wb /m^2 and average current density can be taken as 2.1 A /mm^2, core area factor $K_C = 0.56$.

Estimate :

i) Cross sectional are a of the core

ii) Diameter of the core circle if cruciform section core is used

iii) Window dimensions if the distance between core centers = (2) (width of largest stampings)

iv) Dimensions of the frame. **(08 Marks)**

5 a. Explain the factors to be considered while selecting length of air gap in induction motor. **(10 Marks)**

b. A 1.1 kW; 3 – phase; 50 Hz; 1500 synchronous rpm delta connected induction motor has a stator bore of D = 0.15 m and core length L = 0.06 m. Estimate the main dimensions of a 3.7 kW; 3 –phase 50 Hz; 1000 syn rpm delta connected motor having the same loadings as the previous one. The efficiency and power factors also remain same. Assume same value of $\frac{L}{\tau}$ ratio. **(10 Marks)**

6 a. Give the procedure of estimating end ring current in a 3 – phase squirrel cage rotor, with sketch. **(10 Marks)**

b. A 3 –phase; 50 Hz; 6 – pole; star connected slip ring induction motor has flux per pole as 0.0124 Wb. and voltage between slip rings as 200 V. Determine :

i) Number of stator slots

ii) Number of rotor slots

iii) Number of rotor conductors per slot

Assume rotor slots to be 3 – slots per pole pair less than stator slots and Kwr = 0.95. Give stator core diameter = 0.4 m. **(10 Marks)**

7 a. Define short circuit ratio and explain effects on the design of an alternator. **(10 Marks)**

b. A 500 KVA; 3.3 KV; 50 Hz; 600 rpm; 3 – phase salient pole alternator has 180 turns per phase. Estimate the length of air gap if the average flux density is 0.54 ub /m^2; the ratio of pole arc to pole pitch 0.66; the SCR 1.2; The gap contraction factor 1.15; winding factor 0.955. The mmf required for gap is 80% of no load field mmf and the winding factor 0.955. **(10 Marks)**

8 a. Derive an expression for the output equation of a single phase induction motor. **(06 Marks)**

b. Explain the various factors considered for the selection of armature slots of a 3 – phase synchronous machine.

c. Find the main dimensions of a 2500 KVA; 187.5 rpm 50 Hz; 3 –phase; salient pole synchronous generator. The generator is to be vertical water wheel type. The specific magnetic loading is 0.6 ub /m^2 and the specific electric loading is 34,000 A /m. Use circular poles with ratio of core length to pole pitch = 0.65. Specify the type of pole construction used if the runaway speed is about 2 times the normal speed. **(10 Marks)**

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