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10EE63

Sixth Semester B.E. Degree Examination, Feb./Mar. 2022
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Missing data, if any, may be suitably assumed.

PART – A

1 a. Explain in brief the limitations in design of electrical machines. **(06 Marks)**

b. Classify insulating materials on the basis of temperature and give at least two example of each category. **(06 Marks)**

c. Design a 4-pole; 10KW; 220V; 1000rpm wave wound DC shunt motor with respect to the following :
i) Output coefficient
ii) Main dimensions
iii) Number of armature conductors.
Given specific magnetic loading = 0.45T
Specific electric loading = 17,500A/m
Ratio of gross core length to pole pitch = 0.68
Copper losses are 8% of output
Armature voltage drop 10% of supply voltage. **(08 Marks)**

2 a. Derive the output equation of a DC machine. **(06 Marks)**

b. The following particulars refer to the shunt filed coil for a 440V; 6-pole DC generator mmf per pole = 7000A; depth of winding = 50mm ; Length of inner turn = 1.1m ; Length of outer turn = 1.4m ; Loss radiated from outer surface excluding ends = 1400W/m^2; space factor = 0.62 ; resistivity = 0.02Ω/m and mm^2 calculate :
i) Length of mean turn of field coil
ii) Diameter of bare field conductor
iii) Number of field coil turns
iv) Exciting current in the coil
v) Height of the field coil. **(14 Marks)**

3 a. With usual notations derive the output equation of 3ϕ core type transformer and hence show that $E_t = K\sqrt{Q}$. **(08 Marks)**

b. A 500KVA, 50Hz; 6600/400V; 1-phase core type transformer has the following details maximum flux density = 1.5 Wb/m^2; current density = 2.75A/mm^2; K = 0.8; Net iron area = 0.6 d^2, width of largest stamping for a 3-stepped core is = 0.9d, d-diameter of circumscribing circle window space factor = 0.27; Ratio = $\frac{H_w}{W_w} = 2.5$. Estimate :
i) Window dimensions
ii) Yoke dimensions
iii) Frame dimensions
iv) Winding details comprising number of turns and cross sectional areas of conductors. **(12 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 airgap	
Maximum flux density	= 0.7T
Specific core loss at 50Hz and 0.7T	= 0.5W/kg
Magnetizing force (ampere turns/cm)	= 2.2
Stacking factor	= 0.9
Density of core material	$= 7.5 \times 10^3 kg/m^3$.

(10 Marks)

b. The full load efficiency of a 300KVA transformer is 98.2% at unity power factor. Design the number of cooling tubes necessary if the temperature rise is 35°C. The tank area may be assumed as $4.92m^2$. The tube diameter as 5cm and average length of the cooling tube as 105cm. Heat dissipation may be assumed as $12.5W/m^2/°C$. **(10 Marks)**

PART – B

5 a. Briefly explain the guidelines for selection of stator slots of an induction motor. **(06 Marks)**

b. Write the design procedure of a slip ring induction motor rotor. **(06 Marks)**

c. Calculate the following design information for a 30KW, 440V, 3ϕ, 6-pole, 50Hz delta connected squirrel cage induction motor to operate at a best power factor.

i) Main dimensions of stator frame
ii) Number of turns per phase on stator winding
iii) Number of stator slots
iv) Number of conductors per stator slot

Assume B_{av} = 0.48T; ac/m = 26,000 full load efficiency = 88% ; full load power factor = 86% winding factor = 0.955 ; slots per pole per phase = 3. **(08 Marks)**

6 a. Deduce an expression for a 3-phase induction motor showing. The relationship between its output, main dimensions, specific loadings, efficiency and power factor. **(10 Marks)**

b. A 11KW, 3-phase, 6-pole, 50Hz, 220V star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the values of bar and end ring currents. 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. Also find the bar and ending sections if the current density in both is $5A/mm^2$. **(10 Marks)**

7 a. Discuss the factors affecting the choice of specific magnetic loadings in case of synchronous machines. **(06 Marks)**

b. Briefly explain the factors which affect the selection of armature slots. **(08 Marks)**

c. Find the main dimensions of a 2500KVA ; 187.5rpm; 50Hz; 3-phase; 3KV salient pole synchronous generator. The specific magnetic loading is $0.6Wb/m^2$ and the specific electric loading is 34000A/m. Use circular poles with ratio of core length to pole pitch = 0.65 assume winding factor as 0.955. **(06 Marks)**

8 a. Enumerate the advantages and drawbacks of providing a large air gap in synchronous machines. **(06 Marks)**

b. Define Short Circuit Ratio (SCR) and explain its significance on machine performance. **(06 Marks)**

c. A 500KVA; 3.3Kv; 50Hz; 600rpm; 3-phase star connected salient pole alternator has 180 turns per phase. Estimate the length of airgap if the average flux density is $0.54 Wb/m^2$. The ratio of pole arc to pole pitch is 0.65. The SCR = 1.2; The gap contraction factor = 1.15 and winding factor is 0.955. The mmf required for gap is 80% of no load field mmf. **(08 Marks)**

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