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10EE63

Sixth Semester B.E. Degree Examination, Dec.2018/Jan.2019

Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Design data book may be used.***
3. ***Assume missing data suitably.***

PART – A

1 a. What are the important considerations for the design of electrical machines? Explain in brief and what are its limitations. **(10 Marks)**

b. i) Show that the output of a d.c. generator with single turn coils is given by the expression

$$P' = \frac{0.03E'VqA}{PN} KW$$

where E′ = average voltage between adjacent conductor segments.
V = peripheral speed of the generator m/sec.

ii) Find the maximum output for a lap wound d.c. generator running at 600 rpm and provided with 40,000 ampere conductors per meter of armature periphery. **(10 Marks)**

2 a. Derive the output equation of DC machine. **(10 Marks)**

b. During the design of armature of a 1000 KW, 500 V, 10 pole, 300 rpm, d.c. compound generator, following information has been obtained:

- External diameter of armature 1.4 m
- Gross core length, 0.35 m
- Flux per pole, 0.105 wb.

Based on the above, design information, find out the following details regarding the design of field system:

i) Axial length of the pole ii) Width of the pole
iii) Height of the pole iv) Pole arc

Permissible loss per square meter of the cooling surface may be assumed 700 W/mt^2. Assume missing data as per the rating of the machine. **(10 Marks)**

3 a. Show that with usual notations Volts/turn $E_t = K\sqrt{K.V.A}$ in the case of a transformer. Explain the factors to be taken into account while selecting the value of constant K. **(10 Marks)**

b. Calculate: (i) Net cross section of core (ii) Gross area of the core (iii) Core dimensions (iv) Window area (v) dimensions of the window, for a 200 kVA, 6600/250 V, 50 Hz single phase, shell type, oil immersed, self cooled, distribution transformer based on the following design parameters.

Window space factor, $K_w = 0.28$ Maximum flux density in the core, $B_m = 1.1$ Tesla
Average current density, $\delta = 2.2$ A/mm^2 Window proportion = 2.5:1
Rectangular core proportion = 1.8:1
Net cross-section of copper in the window is 0.2 time the net cross section of iron in the core. **(10 Marks)**

4 a. Explain the step by step procedure for the design of cooling tubes and calculation of temperature rise in a transformer. **(10 Marks)**

b. A 300 KVA, 11000/440 V, 50 Hz, 3 phase, delta/star, core type oil immersed, self cooled transformer give the following results during the design calculations of magnetic frame and windings.
Centre to centre distance between the cores = 36 cm ; Height of the window = 44 cm;
Height of the yoke = 17 cm ; Total weight of the magnetic frame = 700 kg ;
Average specific loss (Iron) = 2.1 W/kg ; Outer diameter of HV winding = 35 cm
Resistance of LV winding per phase = 0.0047 ohm ; Resistance of HV winding per phase = 9.74 ohms. Based on the above design data, calculate the following:
i) The dimensions of the tank
ii) The temperature rise of the transformer with plain tank
iii) Number of cooling tubes, if the temperature rise is not to exceed 35°C. **(10 Marks)**

PART – B

5 a. Deduce for a 3 phase induction motor expression showing the relationship between H.P output, its main dimensions, speed, the specific electric and magnetic loadings, efficiency and power factor. **(10 Marks)**

b. Determine the main dimensions, number of radial ventilating ducts number of stator slots and the number of turns per phase of a 3.7 KW, 400 V, 3ϕ, 4 pole, 50 Hz, cage induction motor to be shorted by a star-delta shorter. Assume B_{av} = 0.45 Wb/mt^2, ac/m = 23000, efficiency = 0.85 and power factor = 0.84 lagging. **(10 Marks)**

6 a. Discuss in detail, the criteria to be considered for determining the number of rotor slot of a cage induction motor. **(10 Marks)**

b. A 3 phase, 3000 volts, 260 KW, 50 Hz, 10 pole squirrel cage induction motor gave the following results during its preliminary design.
Internal diameter of stator = 75 cm Gross length of stator = 35 cm
Number of stator slots = 125 Number of conductor per slot = 10
Based on the above detail, calculate the following for the squirrel cage rotor.
i) Total losses in the rotor bars
ii) Losses in the end rings
iii) Equivalent resistance of the rotor in terms of stator. **(10 Marks)**

7 a. Explain the design procedure to determine the pole dimensions for a salient pole synchronous machine. **(10 Marks)**

b. During the design of stator of 3 phase, 7.5 KVA, 6.6 KV, 50 Hz, 3000 rpm, turbo generator following information have been obtained.
Internal diameter of stator = 0.75 m
Gross length of core = 0.9 m
Number of stator slots per pole per phase = 7
Sectional area of stator conductor = 190 mm^2
Number of conductors per slot = 4
Based upon the above data, calculate the following:
i) Flux per pole ii) Specific magnetic loading
iii) Specific electrical loading iv) Current density for the stator winding. **(10 Marks)**

8 a. Derive the output equation of synchronous generator. **(10 Marks)**

b. Design the field coil of a 3 phase, 16 poles, 50 Hz salient pole alternator based on the following design information:
Diameter of stator at the gap surface = 1.0 m Gross length of stator core = 0.3 m
Section of pole body = 0.15m × 0.3m Height of the pole = 0.15 m
Ampere turns per pole = 6500 Exciter voltage = 110
Assume suitable data wherever necessary. **(10 Marks)**

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