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10EE63

Sixth Semester B.E. Degree Examination, June/July 2015
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.
3. Design data handbook may be permitted.

PART – A

1 a. Describe how specific magnetic and electric loading play an important role in the design of electrical machines. **(08 Marks)**

b. Determine the main dimensions, number of poles, number of armature conductors, number of slots, conductors per slot and the size of armature conductors and cross sectoral area of armature conductor for a 250 KW, 400 V, 625 A, 600 rpm lap wound compound generator, assuming the following data :
Average flux density in the gap = 0.63 Tesla ; specific electric loading = 33000 amp conductors /mh ; field and armature copper losses = 5% of output ; ratio of pole arc to pole pitch = 0.7 ; pole arc = gross length of armature. Armature drop = 3% of terminal voltage, current density $\delta = 5A/mm^2$; slot pitch = 2.6 cm. **(12 Marks)**

2 a. Obtain an expression for field ampere turns per meter height, of a DC machine in terms, permissible loss, copper space factor and depth of winding. **(10 Marks)**

b. A 50 hp, 4–pole, 480 V, 600 rpm shunt motor has a wave wound armature with 770 conductors. The leakage factor for the poles is 1.2. The poles are to be of circular in cross section the field coils are 70 mm thick and produce an mmf of 10,000 A per pole. The flux density in the poles is 1.5 Wb/m^2 calculate :
i) diameter of poles
ii) diameter of field wire
iii) length of field coil
iv) turns per pole and
v) field current. **(10 Marks)**

3 a. Determine the following for a 200 KVA, 50Hz 6600/250V, single phase, shell type, oil immersed distribution transformer, i) net cross section of core ii) gross area of core iii) core dimensions iv) window area v) dimensions of window.
Assume :

Window space factor	= 0.28
Maximum fluxdensity in core	= 1.1 Tesla
Average current density	= 2.2 A/mm^2
Window proportions	= 2.5 : 1
Rectangular core proportions	= 1.8 : 1
Stacking factor	= 0.9

Net cross – section of copper in the window is 0.2 times the net cross section of iron in the core, do not attempt the problem using emf per turn equation. **(10 Marks)**

b. Explain the procedure to determine the no-load current of transformer with relevant expressions. **(10 Marks)**

4 a. Derive the expression for leakage reactance of core type transformer. **(10 Marks)**

b. Explain the design of tank with tubes for the transformer, starting from the determination of temperature rise of transformer. **(10 Marks)**

PART – B

5 a. Determine the main dimensions, turns per phase, number of slots, conductor cross section, and slot area, of a 250 hp, 3 -- phase, 50 Hz, 400V, 1500 rpm, slip ring induction motor. Assume :

B_{avg} = 0.5 Wb/m^2
ac = 30000 A/m
Efficiency = 0.9
Power factor = 0.9
Winding factor = 0.955
Current density = 3.5 A/mm^2
Slot space factor = 0.4
Ratio of core length to pole pitch = 1.2
The number of slots per pole per phase = 5
The machine is delta connected. **(10 Marks)**

b. Describe the factors that affect the estimation of length of airgap in the design of induction motor. **(10 Marks)**

6 a. Explain the step–by–step design procedure of designing squirrel cage rotor for induction motor. **(10 Marks)**

b. Design a wound rotor for a 3–phase, 850 KW 6600V, 50Hz, 12 pole, induction motor with full load efficiency of 92% and power factors of 0.91, based on the following informations :

Gross length of stator	= 45 cm
Internal diameter of stator	= 122 cm
Number of stator slots	= 144
Number of conductors per slot	= 10
Number of rotor slots per pole per phase	= 3½
Voltage between slip rings at starting	= 600V
Current density	= 5A /mm^2

The machine is star connected. **(10 Marks)**

7 a. Derive the output equation in terms of specific loadings for a synchronous machine. **(10 Marks)**

b. Calculate : i) flux per pole, ii) specific magnetic loading, iii) specific electrical loading, iv) current density for a stator winding of 3–phase 7.5 KVA, 6.6 KV, 50 Hz, 3000 rpm, turbo generators based on following design information.

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 conductors per slot	= 4
K_w	=0.955. The machine is star connected. **(10 Marks)**

8 a. Explain the step-by-step procedure to design field winding for salient pole alternator. **(10 Marks)**

b. Design the field coil of a 3 – phase, 16 poles 50Hz 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	= 0.15 m × 0.3 m
Height of pole	= 0.15 m
Ampere turns per pole	= 6500
Exciter voltage	= 110 V

Assume ; 30 volts as reserve ; depth of field coil,
d_f = 0.03 m and insulation of pole = 0.01 m ; current density = 2.6 A/mm^2. **(10 Marks)**

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