EE62

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NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2006
Electrical and Electronics Engineering
Electrical Machine Design

Time: 3 hrs.] [Max. Marks:100

Note: 1. *Answer any FIVE full questions.*
2. *Missing data may be suitably assumed.*
3. *Use of design data hand book is permitted.*

1 a. Explain specific loadings and the usual range of values for each of the loading. **(05 Marks)**

b. Classify the insulating materials used in electrical machines based on thermal considerations. **(07 Marks)**

c. Explain the various factors that affect the choice of number of poles of a DC machine. **(08 Marks)**

2 a. Show that the output of a DC generator with single turn coil is given by,

$$P' = \frac{.03E'vqA}{PN} KW$$

Where E' = Average voltage between adjacent commutator segments,
v = Peripheral speed of the generator in m/sec,
P = Number of poles,
N = Speed in rpm. **(10 Marks)**

b. Calculate the diameter and the length of armature for a 7.5 KW, 4 pole, 1000 rpm, 220 V shunt motor.
Given : Full load efficiency = 0.83, Maximum gap flux density = 0.9 wb/m^2, Specific electric loading = 30,000 AC/meter, field form factor = 0.7. Assume that the maximum efficiency occurs at full load and the field current is 2.5% of rated current. The pole face is square. **(10 Marks)**

3 a. During the design of armature of a 1000 KW, 500 V, 10 pole, 300 r.p.m DC compound generator, following information has been obtained i) External diameter of armature 1.4 m ii) Gross core length 0.35 m iii) flux per pole 0.105 wb. Based on the above design information, find out the following details of the field system, i) Axial length of pole ii) Width of pole iii) Height of the pole iv) Pole arc. **(12 Marks)**

b. Prove that EMF/turn of a single phase transformer = $K\sqrt{Q}$, where Q = per phase KVA output of transformer. **(08 Marks)**

4 a. Derive an expression for the leakage reactance of a transformer with primary and secondary cylindrical coils of equal length, stating clearly the assumptions made. **(10 Marks)**

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4 b. Calculate the active and reactive components of no load current of a 400 V, 50 Hz, single phase transformer having the following particulars:
Stacking factor = 0.9 ; Density = 7.8 x 10^3 kg/m^3 ; Length of mean flux path 2.2 m ; Gross iron section = 100 cm^2 ; Primary turns 200 ; Joints equivalent to 0.2 mm of air gap. Use the following data : **(10 Marks)**

Bm (wb/m^2)	0.9	1.0	1.2	1.3	1.4
MMF(AT/m)	130	210	420	660	1300
Iron loss (Watts/kg)	0.8	1.3	1.9	2.4	2.9

5 a. The full load efficiency of a 300 KVA 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 4.92 m^2. Assume tube diameter as 5 cm and average length as 105 cm. Heat dissipation may be assumed as 12.5 w/m^2/°C. **(10 Marks)**

b. Deduce for a 3 phase induction motor an expression showing the relationship between its output, the main dimensions, specific electric and magnetic loading, efficiency and power factor. **(10 Marks)**

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

b. Estimate the stator core dimensions, number of slots and number of stator conductors per slot for a 100 KW, 3300 V, 50 Hz, 12 pole star connected slip ring induction motor.
Assume: Average gap density=0.4 Tesla, Conductors per meter =25,000 A/m
Efficiency = 0.9, Power factor = 0.9 and Winding factor = 0.96. Choose main dimensions to give best power factor. The slot loading should not exceed 500 Ampere conductor. **(10 Marks)**

7 a. What is meant by the terms crawling and cogging in case of a 3 phase induction motors? What steps are taken in the design procedure to minimize these tendencies? **(08 Marks)**

b. A 3 phase, 3000 volts, 260 KW, 50 Hz, 10 pole squirrel cage induction motor gave the following results during the preliminary design,
Internal diameter of stator = 75 cm,
Gross length of stator = 35 cm,
Number of stator slots = 125
Number of conductors / slot = 10
Based on the above data, 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 rotor in terms of stator. **(12 Marks)**

8 a. Explain the various factors to be considered while selecting the number of slots in the stator of a 3 phase synchronous machine. **(08 Marks)**

b. Explain short circuit ratio of a synchronous machine. What are its effect on the performance of the synchronous machine? **(06 Marks)**

c. Determine the main dimensions for a 1000 KVA, 50 Hz, 3 phase, 375 rpm alternator. The average air gap flux density is 0.55 wb/m^2 and the ampere conductors per meter is 28,000. Use rectangular poles and assume a suitable value for the ratio of core length to pole pitch. The maximum permissible peripheral speed is 50 m/sec. The run away speed is 1.8 times the synchronous speed. **(06 Marks)**

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