EE62

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NEW SCHEME

Sixth Semester B.E. Degree Examination, July 2007
Electrical & Electronic Engineering
Electrical Machine Design

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

Note :1. ***Answer any FIVE full questions.***
2. ***Assume missing data suitably.***
3. ***Design data book may be used if necessary.***

1 a. Explain the principles of design of electrical machines. What are the limitations in the design? **(06 Marks)**

b. What are the desirable properties of magnetic materials? Explain in brief the magnetic materials? Explain in brief the characteristics and applications of sheet steels. **(07 Marks)**

c. What are the desirable properties of insulating materials? Explain the classification of insulating materials based on thermal consideration with two examples in each class. **(07 Marks)**

2 a. Define specific electrical and magnetic loadings for DC machines. Derive the output equation for DC machines. Explain in brief the factors to be considered during the choice of specific loadings. **(10 Marks)**

b. Find the main dimensions of a 37 KW, 230 V, 1400 rpm DC shunt motor with square pole face. Take average gap density 0.5 wb/m^2 and the specific electric loading 22000 ampere conductor per meter. The ratio of pole arc to pole pitch ratio 0.7 and full load efficiency 0.9. Also find the number of armature conductors and size of conductors.

Assume current density as 3 A/mm^2. **(10 Marks)**

3 a. Derive output equation and expression for voltage per turn for a 3 phase transformer, with the details of the symbols used. **(10 Marks)**

b. Determine the main dimensions and winding details of a 100 KVA, 2000/400 Volt, 50 Hz single phase shell type transformer. Take voltage per turn 10 V, flux density in core 1.1 wb/m^2, current density 2 A/mm^2, window space factor 0.33. The ratio of window height to window width is 3 and the ratio of core depth to width of central limb is 2.5. The stacking factor is 0.9. **(10 Marks)**

4 a. Explain the determination of temperature rise in a transformer with plain walled tank and the transformer with tank with oil tubes and the determination of number of oil tubes required. **(10 Marks)**

b. A 750 KVA, 6600/440 V, 50 Hz, 3 phase delta/star core type transformer has the following data : Width of LV winding 30 mm, width of HV winding 25 mm. Width of duct between LV and HV winding 15 mm. Height of windings 0.4 m, length of mean turn 1.5 m. Number of turns in HV winding 217. Estimate the leakage reactance of the transformer as referred to primary side. Estimate the percentage voltage regulation of full load and 0.8 p.f. lag if total resistance / phase as referred to HV side is 0.8 Ω. **(10 Marks)**

5 a. Define specific magnetic loading and specific electric loading for 3 phase AC machines. Derive output equation for 3 phase induction motor with the details of the symbols used. **(10 Marks)**

b. Determine the main dimensions, turns/phase, number of slots, conductor size and area of slot of 250 H.P., 3 phase, 50 Hz, 400 V, 1410 rpm, slipring induction motor. Assume Bav = 0.5 wb/m^2, ac = 30000 A/m, efficiency 0.9 and power factor 0.9. winding factor = 0.955, current density = 3.5 A/mm^2. Slot space factor is 0.4 and the ratio of core length to pole pitch is 1.2. The stator is delta connected. **(10 Marks)**

6 a. Explain the factors considered for the choice of the number of rotor slots in induction motors, and the rules for selecting the number of rotor slots. **(10 Marks)**

b. A 11 kW, 3 phase, 6 pole, 50 Hz, 415 V, delta connected induction motor has 54 stator slots, each containing 9 conductors. Find the currents in rotor bar and end rings. The number of rotor bars is 64. Efficiency of the machine 0.86 and power factor 0.85. Assume rotor mmf as 0.85 times stator mmf. Also find the size of each rotor bar and end ring if current density is 5 A/mm^2. **(10 Marks)**

7 a. Derive an expression for the resistance of cage rotor / phase as referred to stator. What is the effect of rotor resistance on the performance of an induction motor? **(10 Marks)**

b. Determine the equivalent resistance of rotor/phase as referred to stator referring the following data for a 3 phase, 440 V, 50 Hz squirrel cage induction motor. Number of stator slots = 48 with 30 conductors per slot. Number of rotor slots = 53 with one bar in each slot. Length of each bar 0.12 m and C/S area 60 mm^2. The end rings have mean diameter of 0.18 m and area of C/S 150 mm^2. Full pitched winding with 60° phase spread for stator. Take resistivity for rotor bar and end ring as 0.021 Ω-mm^2/m. **(10 Marks)**

8 a. Define short circuit ratio in connection with 3 phase synchronous generator. Explain the factors affected by SCR. **(10 Marks)**

b. Determine the main dimensions, the number of stator turns/phase and number of total stator conductors and stator conductor size for a 3 phase 500 KVA, 6600 V, 12 pole, 500 rpm alternator. Assume star connected stator with specific loadings of 0.6 wb/m^2 and 30000 A/m. Take the ratio of armature length to pole pitch as 1.5. Assume winding factor 0.96 and δ = 3 A/mm^2. **(10 Marks)**