Roll No .....

EE-603 (GS)

B.E. VI Semester

Examination, December 2017

Grading System (GS)

Electrical Machine Design

Time : Three Hours

Maximum Marks : 70

Note: i) Attempt any five questions.

ii) All questions carry equal marks.

1. a) State and explain in brief the concept of mathematical programming methods for the design of electrical machine.

   b) Describe the basic properties of unconstrained and constrained optimization problems.

2. a) Describe the step by step procedure of designing a shunt field winding for a dc machine.

   b) Calculate the diameter and length of armature for a 7.5kW, 4-pole, 1000rpm, 220V dc shunt motor. Given full load efficiency = 0.83, maximum flux density = 0.9Wb/m^2, specific electric loading = 30000 Ac/m, field form factor = 0.7. Assume that the maximum efficiency occurs at full load and field current is 2.5% of rated current. The pole face is square.

3. a) Derive the output equation of a dc machine. State the factors to be considered for the selection of variables for optimal design.

   b) Find the main dimensions and number of poles of a 1000kW, 500V, 300rpm dc generator. Assume the specific loading, $B_{av} = 0.7$Wb/m^2. Ampere conductor/m = 40,000, square pole face, ratio of pole arc to pole pitch is 0.7. Assume efficiency as 92% and gap contraction factor as 1.15.

4. a) Derive the output equation of a three-phase core type transformer. Explain the choice of magnetic and electric loading.

   b) Determine the dimension of core for a 200kVA, 50Hz, three-phase core type transformer. A cruciform core is used with distance between adjacent limbs equal to 1.6 times the width of core laminations. Assume voltage per turn = 14V, maximum flux density = 1.1 Wb/m^2, window space factor = 0.32, current density = 3A/mm^2 and stacking factor = 0.9. The net iron area is $0.56d^2$, where d is the diameter of circumscribing circle. Also the width of the largest stamping is 0.85d. Assume CRGO steel.

5. a) Derive the output equation of a synchronous machine and show that $HP = \dfrac{Input\ KVA \times n \times \cos\theta}{0.746}$.

   b) Obtain the suitable values of diameter and core length for a 1500kVA, 3300V, 3-ϕ, delta connected, 10 pole alternator which has magnetic loading 0.5T and specific electric loading 34,000 A/m. The ratio of pole pitch to core length is 0.8. Assume winding factor as 0.955, frequency = 50Hz.

6. a) Discuss the factors to be considered while deciding the length of air gap, number of stator and rotor slots for 3-ϕ induction motor.

   b) Find the magnetizing current and no load power factor of a 15HP, 440V, 6-pole delta connected slipring induction motor having the following data:

   Number of stator slots = 54

   Conductor/slot = 28

   Flux/pole = 8.25 mWb

   Gap area/pole = 183.5cm^2

   Gap length = 0.55mm

   Iron loss = 510W

   Friction and windage losses = 110W

   Gap expansion coefficient = 1.33

   Iron parts of magnetic circuit requires 20% of ATs required for the gap. Assume winding factor $k_w = 0.96$.

7. a) What is meant by the term crawling and cogging in case of 3-phase induction motors? What steps would you take in the design procedure, so as to minimize the tendencies?

   b) What is the role of damper bars in the alternator? Write an algorithm for the field system design of a 3-ϕ alternator.

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8 Write short notes on any two of the following:

   a) Linear programming and NLP techniques

   b) Algorithm for optimal design of dc machine

   c) Design of squirrel cage rotor

   d) Significance of objective function and constraint functions

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