U.S.N | | | | | | | | | |

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. – Electrical and Electronics Engineering

Semester End Examination; June/July - 2015

Electrical Machine Design

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer any **FIVE** full questions, selecting atleast **TWO** full questions from each part.*

PART - A

1. a. What are the major considerations to evolve a good design? Briefly explain them. 6

b. Explain the limitations of electrical machine design. 7

c. What are the recognized classes of insulating materials and the temperatures assigned to them. Give at least one example for each. 7

2 a. Define specific electrical and magnetic loadings for D.C. machines. Derive the output equation for D.C. machines. 8

b. Find the main dimensions of a 37 kW, 230 V, 1400 rpm dc shunt motor with square pole face. Take average gap density as 0.5 wb/m^2 and specific electric loading 22,000 A conductors/m. The ratio of the pole are to pole pitch is 0.7 and full load efficiency is 0.9, Also find the number of armature conductors and size of the conductors. Take the current density as 3 A/mm^2. 12

3 a. For a transformer, show that the emf per turn E_t is given by $E_t = K\sqrt{KVA}$, where K is a constant and KVA is the rating of the transformer. What are the factors on which the value of K depends? 8

b. Determine the main dimensions of a 350 kVA, three-phase, 50 Hz, Star/delta. 11000/3300 V, core type distribution transformer. Assume distance between Core centres as twice the width of the core. For a 3- phase core type transformer. 12

$E_t = 0.45\sqrt{KVA}$ and take B_m = 1.3 wb/m^2. Assume a 3-stepped core,, and k_w = 0.33 and H_w/w_w = 2.5

4. a. Explain the procedural steps for estimating the no-load current of a transformer. 8

b. A 250 kVA, 6600/440 V, 50 Hz, 3-phase star/delta, core type oil immersed, natural cooled transformer gave the following results during the design calculations. 12

Length of the core plus twice the height of the yoke = 85 cm.

Centre to centre distance between the core sections =32 cm

Outside diameter of the H.V. winding = 31 cm.

Total iron loss = 1500 watts, Copper loss in the L.V. winding = 1200 watts.

Copper loss in the H.V. winding = 2050 watts.

Contd...2

Calculate the main dimensions of the tank, temperature rise of the plain tank, and the number of cooling tubes required if the temperature rise is not exceed 35°C.

PART – B

5 a. Derive the output equation of a 3-phase Induction motor with usual notations. Briefly explain the factors to be considered during the choice of specific electric and magnetic loadings. 10

b. Find the main dimensions of a 20 HP, 3-phase 400 V, 50 Hz, 2810 r.p.m. squirrel cage inductions motor having the following data, efficiency = 88. Power factor = 0.9, B_{av} = 0.5 T, q = 25,000 ac/m, Rotor peripheral speed = 20 m/s. 10

6. a. Explain the factors that affect the choice of length of air gap of an Induction motor. 10

b. Determine the copper loss in each end ring of the 4 pole, cage rotor induction rotor, to which the following data, applies number of stator conductors = 432, stator current/conductor = 230 A, Number of rotor conductors = 83, Mean diameter of the end ring = 60 cm section of the end ring = 5cm x 2 cm, resistivity of the end ring material = 1.8 μΩ-cm. 10

7. a. Define the short circuit ratio in connection with three-phase synchronous generator. Explain the factors which affect the performance of the machines. 10

b. Determine the suitable values for stator bore diameter and core length, number of stator slots, conductors for a 5000 kVA, 11 kV, 3-phase, 50 Hz, 20 pole, water turbine generator subjected to an over speed of 50%. 10

Assume average flux density = 0.5 T, specific electric loading = 50,000 A conductors/m. The peripheral speed is not to exceed 70 m/s.

8. a. Explain the factors to be considered for the selection of number of slots in the stator of a 3-phase synchronous machine. 10

b. The field coils of a salient pole alternator are wound with a single layer winding of bare copper strip, 30mm deep, with separated insulation of 0.15 mm thick. Determine a suitable winding length, number of turns, and thickness of conductor to develop an mmf of 12,000 AT, with a potential difference of 5 V/coils and with a loss of 1.2 kW/m^2 of total coil surface. The mean length of the turn is 1.2 m. The resistivity of copper = 0.021 Ω/m/mm^2. 10

* * * * *