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

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

(An Autonomous Institution affiliated to VTU, Belagavi)

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

Semester End Examination; May / June - 2018

Electrical Machine Design

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. What are the limitations in the design of electrical machines? Explain. 6

b. Define specific loadings and mention the advantages of choice of higher value of specific loadings in the design of machines. 4

c. A design is required for a 50 kW, 4 pole, 600 rpm, DC shunt generator, the full load terminal voltage being 220 V. If the maximum gap density is 0.83 Wb/m^2 and the armature ampere conductors per meter are 30,000. Calculate suitable dimensions of armature core. Assume that the full load armature voltage drop is 3% of the rated terminal voltage and that the field current is 1% of rated full load current, $\psi = 0.67$. 10

2 a. Derive the output equation of DC machine. 6

b. List the desirable properties of insulating materials. 6

c. Determine the main dimensions of number of poles of a 1000 kW, 500 V and 350 rpm DC generator. Assume the average air gap density as 0.68 Tesla and Ampere conductors/meter as 40,000. The ratio of pole arc to pole pitch is 0.68 (The ratio of length to pole pitch is 0.75. Assume η = 90%) current per brush arm not to exceed 400 Amperes and frequency of the flux reversals in the armature not to exceed 50 Hz. 8

UNIT - II

3 a. Discuss the factor which influences the selection of number slots. 8

b. During the design of armature of 1000 kW, 500 V, 10 pole, 300 rpm, DC compound generator, following information has been obtained: External diameter of armature = 1.4 m = D;

Gross core length = 0.35 m = L; Flux / pole = 0.105 wb = ϕ

Based on above design information find out following details regarding the design of the field system: 12

i) Axial length of the pole ii) Width of the pole iii) Height of the pole iv) Pole arc

v) Depth of yoke permissible loss/sq.m of the cooling surface may be assumed 700 W/m^2 (P_f) Assume missing data as per the rating of machine.

4 a. Derive the expression for field Ampere turns /meter height in case of DC machine. 8

b. A shunt field coil has to develop an mmf of 9000 AT. The voltage drop in the coil is 40 V and resistivity of round wire used is 0.021 Ω/meters/mm^2. Depth of winding is 35 mm approximately and length of mean turn is 1.4 m. Design a coil so that the power dissipated is 700 W/m^2 of the total coil surface (outer, inner top and bottom). Take the diameter of the insulated wire to be 0.2 mm greater than the Bare copper. 12

Contd…2

UNIT - III

5 a. Derive the output equation of a 3-ϕ transformer. 8

b. Determine the dimensions, number of turns and cross section of LV and HV conductor for a single phase core type transformer of 200 kVA, 6600/440 V, $B_{max} = 1.3$ wb/m^2, $\delta = 2.5$ A/mm^2, window space factor $K_w = 0.3$. Assume cruciform cross section for the core $H_W/W_W = 1.5$, $E_t = 9$ V. 12

6 a. Write an expression for leakage reactance of a core type transformer and state the assumption made. 10

b. A 300 kVA, 1100/440 V, 50 Hz, 3 phase, Δ/Y core type oil immersed, self cooled transformer gave the following results during the design calculations of magnetic frame and windings :

Centre to centre distance = 36 m; H_w = 44 cm; H_y = 17 cm; M_w = 700 kg; Average specific loss = 2.1 W/kg; D_o of HV = 35 cm; LV resistance = 0.0047 Ω; HV resistance = 9.74 Ω 10

Based on above data, calculate; i) Dimension of tank ii) Temperature iii) Number of cooling tubes.

UNIT - IV

7 a. With usual notations, derive output equation for a 3 phase induction motor. 6

b. During the preliminary design of a 5 kW, 400 V, 3 phase, 4 pole, 50 Hz, delta connected squirrel cage induction motor, following information has been obtained;

Gross length of Stator = 0.1 m; Stator Bore diameter = 0.17 m

Estimate the stator bore diameter and the gross length for 7.5 kW, 3 phase, 400 V, 4 pole, 50 Hz, delta connected, Squirrel cage induction motor, designed with the same specific loading as the previous one. Assume the data missing. 14

8 a. What are the factors to be considered for estimating the length of air gap for induction motors? Explain these factors. 6

b. Calculate:

i) Suitable Main dimensions ii) Number of turns and slots iii) Conductor section and size of slot

For the stator of a 3 phase, 3000 V, 10 poles, 50 Hz, Induction motor developing 270 kW. Choose suitable values for data missing. 14

UNIT - V

9 a. Explain design procedure for designing the field winding of a salient pole alternator. 10

b. Calculate the main dimensions of a 1000 kVA, 50 Hz, 3 phase 375 rpm alternator. The average air gap flux density is 0.55 wb/m^2, Ampere conductors/m are 28,000. Assume ratio of core length to pole pitch = 2 and winding factor = 0.955 permitted maximum peripheral speed is 50 m/s. 10

10 a. Define SCR and explain its effect on machine performance. 10

b. A 500 kVA, 3.3 kV, 50 Hz, 600 rpm, 3 phase salient pole alternator has 180 turns/phase. Calculate the length of the air gap. If the average flux density is 0.54 wb/m^2, ratio of pole arc to pole pitch 0.66, SCR is 1.2, the gap contraction factor is 1.15 and winding factor is 0.955. The mmf required for air gap is 80% of no load field mmf. 10

* * * *