Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B E Sem-VI Examination May 2011

Subject code: 160804

Subject Name: Electrical Machine Design

Date:21/05/2011 **Time: 10.30 am – 01.00 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** What are the factors that limit the design of an electrical machine? **07**

(b) A 15KW, 230V, 4-pole d.c. machine has the following data: **07**
Armature diameter 0.25m, armature core length 0.125m, air gap length at pole centre 2.5mm, flux per pole 11.7mWb, ratio of pole arc to pole pitch 0.66.
Calculate the mmf required for air gap (i) if the armature surface is treated to be smooth (ii) if the armature is slotted and the gap contraction factor is 1.18.

Q.2 **(a)** What are the fundamental requirements of conducting materials? **03**

(b) Why is the transformer core preferred to have a step construction? **02**

(c) Distinguish between real and apparent flux densities. **02**

(d) Explain how eddy current loss occurs and derive an expression for eddy current loss in a magnetic material. **07**

OR

(d) Explain radial and axial ventilation with the help of sketches. Give the advantages of hydrogen cooling in alternators. **07**

Q.3 **(a)** The inner dimensions of the former of field coil of d.c. generator are 150mm x 250mm. The former is 2.5mm thick. Calculate the heat conducted across the former from winding to core if there is an air space 1mm wide between the former and the pole core. The thermal conductivity of former and air is 0.166W/m-°C and 0.05W/m-°C respectively. The winding height is 200mm and the temperature rise is 40°C. **05**

(b) How are machines classified based on its ratings? Show the temperature variation for any one type. **02**

(c) Describe the various methods of cooling of transformers. **07**

OR

Q.3 **(a)** Explain the three methods for calculation of mmf in the teeth. **05**

(b) Define stacking factor. **02**

(c) Explain the design procedure in the design of field windings for a d.c. shunt machine. **07**

Q.4 **(a)** Derive the output equation of a single phase transformer. **07**

(b) Determine the dimensions of core and yoke for a 200KVA, 50Hz single phase 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 1.1Wb/m^2, window space factor 0.32, current density 3A/mm^2. The net iron area is $0.56d^2$ in a cruciform core and the width of the largest stamping is 0.85d, where d is the diameter of the circumscribing circle. **07**

OR

Q.4 **(a)** A single phase, 400V, 50 Hz transformer is built from stampings having a relative permeability of 1000. The length of the flux path is 2.5m, the area of cross section of the core is $2.5x10^{-3}$ m^2 and the primary winding has 800 turns. The iron loss at the working flux density is 2.6 W/Kg and iron weighs 5.8×10^{-3} Kg/m^3. Stacking factor is 0.9. Estimate the maximum flux and no load current of the transformer. **07**

(b) A 100KVA, 11000/440 V, 50 Hz, 3 phase, delta/star, core type, oil immersed self cooled transformer gave the following results during the design calculations of magnetic frame and windings: **07**

Tank length 1.15m, tank width 0.45m, tank height 1.23m, total iron losses 1470W, resistance of l.v winding per phase 0.0047Ω, resistance of h.v winding per phase 9.74Ω. The specific heat dissipation from the tank walls is $6W/m^2$-ºC and $6.5W/m^2$- ºC due to radiation and convection respectively. Assume the loss dissipation through convection is improved by 35% in tubes.

Design a suitable tank for the transformer such that the average temperature rise of oil should not exceed 35ºC.

Q.5 **(a)** The field coils of a salient pole alternator are wound with a single layer winding of bare copper strip 30mm deep, with separating insulation of 0.15mm thick. Determine a suitable winding length, number of turns and thickness of conductor to develop an mmf of 12000A with a potential difference of 5V per coil and with a loss of 1200 W/m^2 of total coil surface. The mean length of turn is 1.2m. The resistivity of copper is $0.021x10^{-6}$Ω-m. **07**

(b) What are the factors that affect the size of rotating machines? **04**

(c) Mention various factors on which brush friction loss depends. **03**

OR

Q.5 **(a)** A 5KW, 250V, 4 pole, 1500rpm shunt generator is designed to have a square pole face. The loadings are: **07**

Average flux density in the air gap $0.42Wb/m^2$ and ampere conductors per metre 15,000. Find the main dimensions of the machine. Assume a full load efficiency of 0.87 and ratio of pole arc to pole pitch 0.66.

(b) Define specific magnetic loading and specific electric loading in relation to rotating electrical machines. **04**

(c) Mention any three criteria for selecting rotor slots in an induction motor. **03**

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