B.E. Electrical (Electronics & Power) Engineering Sixth Semester

EP605 - Design of Electrical Machines

P. Pages : 3 **GUG/W/18/1686**

Time : Three Hours * 1 3 2 5 * Max. Marks : 80

Notes : 1. All questions carry equal marks.
2. Illustrate your answers wherever necessary with the help of neat sketches.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Use of non programmable calculator is permitted.

1. a) Classify the insulating materials based on thermal considerations. Give examples for each classification. **8**

b) Derive the relation between mechanical overload ratio and heating overload ratio. **8**

OR

2. a) The power loss in naturally cooled transformer is 20kw on full load and its rate of dissipation of heat 0.4 kw/ºC rise of temperature. The heat energy required to raise the temperature by 1ºC is 0.8kwh. Find the rise of temperature. **8**
i) Two hours after switching on if the current is constant over this period at half the load value and
ii) After a further hour on full load. At half load, the Copper loss is equal to iron loss.

b) What are the major considerations accounted for the good design of electrical machines. **4**

c) Draw the heating curve for the electrical machines. **4**
i) The final steady temperature rise
ii) Heating time constant.

3. a) Derive an expression for volts/turn of transformer. **6**

b) Calculate the main dimensions for a 250 kVA 6600/415V, 50Hz, 3 phase core type transformer. **10**
Assume the following data Emf/turn = 10V, maximum value of flux density = 1.1 tesla. Current density $2 \cdot 5 A/mm^2$, Window space factor = 0.3 overall height = overall width, stacking factor = 0.9 Use a 3 stepped core, the width of largest stamping is 0.9, Net iron area $= 0.6d^2$ where d = diameter of the circumscribing circle.

OR

4. a) Why tapping are provided on h.v. side of transformer? **6**

b) A 750kVA, 6600/440V, 50Hz, single phase shell type transformer has Sandwich Coils. There are 3 full h.v. coils. Calculate the value of leakage reactance referred to h.v. side. Also calculate p.u leakage reactance and p.u. regulation at 0.8pf (lag) if p.u. resistance is 0.1. **10**

The data given is:
depth of h.v. coil = 60mm
depth of l.v. coil = 45mm
depth of duct between hv and lv = 25mm,
width of windings = 200mm.
length of mean turn = 2m.
The number of turns of h.v. winding = 660.

5. a) Derive an expression for leakage reactance of transformer referred to HV Side. **6**

b) Calculate the active and reactive components of no load current of a 400V, 50Hz, single phase transformer having the following particulars: **10**
Stacking factor = 0.9; Density $= 7 \cdot 8 \times 10^3 \text{ kg/m}^3$; Length of mean flux path $2 \cdot 2\text{m}$; Gross iron section = 100 cm^2 ; Primary turns 200; joints equivalent to $0 \cdot 2$ mm of air gap. Use the following data:

$B_m \left(\text{wb/m}^2\right)$	$0 \cdot 9$	$1 \cdot 0$	$1 \cdot 2$	$1 \cdot 3$	$1 \cdot 4$
MMF (AT/M)	130	210	420	660	1300
Iron loss (Watts/kg)	$0 \cdot 8$	$1 \cdot 3$	$1 \cdot 9$	$2 \cdot 4$	$2 \cdot 9$

OR

6. a) The full load efficiency of a 300kVA transformer is $98 \cdot 2\%$ at unity power factor. Design the number of cooling tubes necessary, if the temperature rise is 35ºC. The tank area may be assumed as $4 \cdot 92\text{m}^2$. Assume tube diameter as 5cm and average length as 105cm. Heat dissipation may be assumed as $12 \cdot 5 \text{ w/m}^2/^\circ\text{C}$. **8**

b) Write short note on **any two.** **8**

i) Necessity of tap changer.

ii) Comparison of distribution and power transformer.

iii) Different mechanical forces acting on transformer.

7. a) Why a great majority of induction motors are made with squirrel cage rotors? **6**

b) Estimate the main dimensions, air gap length, number of stator slots, stator turns per phase and cross sectional area of stator conductors for a 3 ph., 20Hp, 415volts, 6 pole, 50Hz induction motor suitable for self starting. Assume magnetic and electric specific loadings as $0 \cdot 45 \text{ wb/m}^2$ and 23,000 ac/m respectively, ratio of core length of pole pitch 0.85, full load efficiency 88% and power factor 0.89. **10**

OR

8. a) How to find end ring current in terms of bar current? **4**

b) A 15kw, 3 phase, 6-pole 50Hz squirrel cage induction motor has the following data: **12**
Stator bore diameter = 0.32m;
Axial length of stator core = 0.125m;
Number of stator slots = 54
Number of conductor per stator = 24
Current in each stator conductor = 17.5A
Full load power factor = 0.85 lagging
Design a suitable cage rotor giving number of rotor slots, section of each bar and section of each ring. The full load speed is about 950rpm approximately. Use copper for this rotor bars and end rings. Resistivity of Cu is $0.02\,\frac{\Omega(\text{mm})^2}{\text{m}}$.

9. a) Find the main dimensions of a 3000kVA 185rpm 50Hz 3ϕ 3000V salient pole synchronous generator. The specific magnetic loading is $0{\cdot}6\,\text{wb}/\text{m}^2$ and specific electrical loading is 35000 At/m. use the ratio of core length to pole pitch is 0.65. Specify the type of pole construction used if the runaway speed is about two times the peripheral speed. **8**

b) State and Explain the various factors to be considered while selecting the number of slots in the stator of a 3 phase synchronous machine. **8**

OR

10. a) Explain short circuit ratio of a synchronous machine what are its effect on the performance of the synchronous machine? **8**

b) Write short notes on **any two:** **8**

i) Hydrogen cooling of alternator.

ii) Choice of specific magnetic loading for synchronous machine.

iii) Procedure for pole design of salient pole alternator.

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