B.E. Electrical (Electronics & Power) Engineering Sem-VI

EP605 - Design of Electrical Machines

P. Pages : 3 **GUG/S/19/1686**

Time : Three Hours * 1 3 1 0 * Max. Marks : 80

Notes :
1. All questions carry equal marks.
2. Answer **five** questions as per internal choice.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. Use of non-programmable electronics calculator, drawing instruments is permitted.

1. a) Explain graphical method for finding steady temperature rise and heating time constant of machine. **8**

b) The rate of temperature rise as measured from a temperature rise time curve of a d. c. motor is 0.803ºC per minute and 0.0605ºC per minute when temperature rise is 20.5ºC and 28.5ºC respectively. **8**
Calculate
i) Final steady temperature rise
ii) Heating time constant

OR

2. a) What is the short time rating of Electrical machine? Explain it with the help of "Temp. rise Vs Time" curve. **8**

b) The power loss in naturally cooled transformer is 20 kW 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 0.8 kWh. 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 the iron loss.

3. a) Write a short note on:

i) Difference between core and shell type transformer. **4**

ii) Necessity of tap changer. **4**

b) Calculate the main dimensions of the core, number of turns and cross – section of the conductors for a 5 kVA, 50 Hz, single phase core type transformer. A rectangular core is used with long side twice as long as short side. The window height is 3 times the width. Assume, E_t = 1.8 V, k_w = 0.32, $\delta = 1.8\ A/mm^2$ and B_m = 1 Wb/ m^2. **8**

OR

4. a) Write short notes on:

i) Need of stepped core cross – section in transformer. **4**

ii) Position of transformer windings relative to the core. **4**

b) Calculate the main dimensions and winding details of a 100 kVA, 2000/400 volt 50 Hz, single phase shell type oil immersed, self cooled transformer. **8**
Assume:
Voltage per turn – 10V;
Flux density in core – 1.1 Wb/m^2;
Current density – $2A/mm^2$.
Window space factor – 0.33
The ratio of window height to window width = 3 and ratio of core depth to width of central limb = 2.5. The stacking factor is 0.9.

5. a) Why cooling tubes are required for medium sized transformers? **4**

b) A 500 kVA, 6600/400V, single phase core type transformer has the following data:- **12**
Net iron area of limb = $60\times10^3\ mm^2$
Net iron area of Yoke = $70\times10^3\ mm^2$
Height window = 440 mm
Width of Yoke = 745 mm
Maximum flux density in the core = 1.35 Wb/m^2.
Effect of Joints = 2% of iron.

B_m, Wb/m^2.	0.9	1.0	1.2	1.3	1.4
H, AT/m	130	210	420	660	1300
Pi, w/kg	0.8	1.3	1.9	2.4	2.9

Calculate the percentage no load current, considering the effect of joints.

OR

6. a) Describe in brief with the help of diagrams the different methods of cooling of transformer. **8**

b) A 750 kVA, 6600V, 50 Hz, 3ϕ, delta star core type transformer has following data:- **8**
Width of L. V. winding = 30 mm,
Width of H. V. winding = 25 mm,
Width of Duct between LV and HV winding = 15 mm
Height of Windings = 0.4 m,
Length of mean turn = 1.5 m
HV winding turns = 217
Estimate the leakage reactance of the transformer referred to H.V. side. Also find p. u. regulation at full load and 0.8 power factor lagging if the resistance per phase referred to H.V. is 0.8 ohms.

7. a) Explain the phenomena of crawling of 3ϕ induction motor. **4**

b) Estimate outside diameter of stator laminations, no. of stator slots and stator conductors for 100 kW, 3300V, 50 Hz, 12 pole star connected slipring induction motor. **12**
Assume:
Bav = 0.4 Wb/m^2.
ac = 25,000 A/m
efficiency = 0.9
Power factor = 0.9
kws = 0.96
Choose main dimensions to give best power factor.

OR

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

b) A 20 kW, 3ϕ, 440 V, 50 Hz, 1500 synchronous speed, squirrel cage induction motor has the following data:- **12**
Stator bore diameter = 220 m
Axial length of core = 190 mm
No of stator slots = 36
Conductor/ slot = 25
P.F. = 0.88
Efficiency = 0.89
Calculate:-
i) No. of rotor slots and its dimensions
ii) Shaft diameter
iii) Rotor speed on full load

9. a) Discuss the cylindrical and salient pole rotor of synchronous machine & state merits & demerits. **8**

b) A 50 MVA turbo alternator has a total loss of 1500 kW. Calculate volume of air required per second and also the fan power if temperature rise in the machine is to be limited to 30ºC. The other data given is: **8**
Inlet temperature of air = 25ºC.
Barometric height = 760 mm of mercury
Pressure = 2 kN/m^2.
Fan efficiency = 0.4.

OR

10. a) Write a short note on:

i) Direct cooling of turbo alternator. **4**

ii) Run away speed of alternator. **4**

b) Obtain the main dimensions of the rotor of a 50 MVA, 2 pole, 50 Hz, synchronous generator. The peripheral speed is limited to approximately 160 m/sec. Take the electric loading of 65000 A/m and the mean gap density of 0.575 Wb/m^2. Assume the gap length of 25 mm. **8**

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