B.E. (Electrical Engineering (Electronics & Power)) Semester Fifth (C.B.S.)

Electrical Machine Design

P. Pages : 3 **KNT/KW/16/7335**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) Derive the expression for temperature rise of a rotating machine when it is heating. **6**

b) The temperature rise of a transformer is 30ºC after 2 hours and 45ºC after 4 hours of its operation. **7**

i) Calculate the maximum final temperature rise with full load on transformer and the heating time constant.

ii) Calculate time to reach $5/6^{th}$ of its final steady temperature rise.

iii) If its temperature falls from final steady value to 55ºC in 1.5 hours when disconnected , Calculate its cooling time constant. The ambient temperature is 27ºC

OR

2. a) Explain in brief about the HRS & CRGOS materials. **6**

b) A machine running on steady full-load gave the following temperature rise at the end of the specified interval. **7**

Time (hrs)	Temp. rise (ºC)
0.25	9.5
0.50	17.0
1.00	29.2
1.50	38.00
2.00	44.2
2.50	48.7
3.00	52.00

Find graphically the final temperature rise and heating time constant of a machine.

3. a) State and prove the design criteria that results into the minimum weight of the transformer. **5**

b) Calculate the overall dimension for a 200KVA, 6.6KV/440V, 50Hz, Δ/Y, core type $3-\phi$ transformer following data is given : **8**

Voltage per turn = 8V

Current density = 2.5 A/mm^2

Flux density = 1.2 wb/m^2

Stacking factor = 0.9

Window space factor = 0.28

Assume two stepped core

Overall Height = limb spacing

OR

4. a) What is the necessity of tap changers? Explain in brief the construction and working of different tap changers. **6**

b) Determine the main dimensions of core and yoke for 200KVA, 50Hz,1ϕ, core type transformer. A cruciform core is used with distance between adjacent limb = 1.6 times the width of core laminations. Assume voltage per turn = 14V, maximum flux density = 1.1wb/m^2, k_w = 0.32, current density = 3 A/mm^2 and stacking factor = 0.9 Net iron area is 0.56d^2 in a cruciform core where 'd' is the diameter of circumscribing circle. Also the width of largest stamping is 0.85d. **7**

5. a) Give the design procedure for the cooling tank (with tubes) of transformer. **6**

b) Calculate the leakage reactance of transformer referred to HV side, per unit regulation of full load and 0.8 P.F. lagging, if the resistance per phase referred to HV side is 0.8Ω for a 750 KVA, 6600/400V, 50Hz, 3ϕ ΔY type transformer. **7**
Width of LV winding = 30mm
Width of HV winding = 25mm
Radial width of duct = 15mm between HV & LV Coil
Length of mean turn = 1.5m
Height of winding = 0.4m
High voltage winding turns = 217

OR

6. a) Explain elaborately different methods of cooling of transformer. **6**

b) A 6600V, 60Hz, single phase transformer has a core of sheet steel. The net iron cross-sectional area is $22.6 \times 10^{-3}\, m^2$, the mean length is 2.23m and there are four lap joints. Each lap joint takes ¼ times as much reactive mmf as is required per meter of core. If $B_m = 1.1\ wb/m^2$, Determine: **7**

a) The number of turns on the 6600V winding and
b) The no-load current. Assume an amplitude factor of 1.52 and that for given flux density, mmf per meter = 232 A/m, specific loss = 1.76 w/kg, specific gravity of plates = 7.5.

7. a) Discuss the factors which affect and influence the choice of specific electric loading. **6**

b) A 3 – phase, delta – Connected, 25Hp, 415V, 50Hz, 1440 rpm, induction motor has the following specifications: $B_{av} = 0.45\ wb/m^2$, ac = 25,000 A/m, efficiency = 90%, P.F. = 0.89(lag) rotor core length = Pole pitch. Determine the main dimensions, number of stator slots, turns per phase, conductors per slot, area of conductor and dimensions of slot, Find the flux density of stator tooth. **8**

OR

8. a) Discuss output equation of 3-ϕ Induction motor. **6**

b) Determine the main dimensions, turns per phase, number of slots, conductor cross-section and slot area of 250hp, three phase, 50Hz, 400V, 1410 rpm, slipring induction motor, Assume $B_{av} = 0.5\ wb/m^2$, ac = 30,000 A/m, efficiency = 0.9 and power factor = 0.9, winding factor = 0.955, current density = 3.5A/mm^2. The slot space factor is 0.4 and the ratio of core length to pole pitch is 1.2 the machine is delta connected. **8**

9.	a)	Explain in detail the effects of harmonics on the I.M.	**6**
	b)	Following design data are provided for s-phase, 4 pole, 400V, delta connected 10kw, squirrel cage IM: Stator core diameter = 15cm Axial length of stator = 9cm ϕ_m = 4.768 m wb. Number of stator slots = 36 $k_{ws} = 0.96$ Stator Current /phase = 11.53 Amp. Current density in bar and end rings is 5 & 6 A/mm^2, respectively. Length of bar = 13cm. Use copper for rotor bars & end rings. $\rho = 2.1 \times 10^{-8}\,\Omega m$ Design suitable cage rotor giving bar and end ring dimensions. Also determine speed.	**8**

OR

10.	a)	Discuss about the choice of rotor slots for squirrel cage IM.	**6**
	b)	110kw, 33KV, 3ϕ, 50 Hz, synchronous speed 600 rpm slipring induction motor has: Diameter of at air gap = 0.65m, $k_{ws} = 0.95$, Core length = 0.25m, $s_s = 90,\ z_{ss} = 24,\ lg = 1.2\,mm$ At for iron part in 35% of air gap. Find Magnelising current.	**8**
11.	a)	Derive the relation for p.u. armature resistance and p.u. armature leakage reactance for synchronous machine.	**6**
	b)	Find the main dimensions of 100MVA, 11KV, 50Hz, 150 rpm, 3 phase water wheel generator. The average gap density is 0.65 wb/m^2 and ampere conductors per meter are 40,000. The peripheral speed should not exceed 65m/s, at normal running speed in order to limit the run-away peripheral speed.	**7**

OR

12. Write a short note on:

a)	Various cooling methods employed for turbo-alternator.	**5**
b)	Difference between salient pole rotor and cylindrical rotor machine.	**4**
c)	Advantages of Hydrogen cooling of Turbo-alternator.	**4**

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