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

Electrical Machine Design

P. Pages : 3 **NRJ/KW/17/4475**

Time : Three Hours * 0 4 0 9 * 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.

1. a) The heat run on a d. c. motor gave the following result. **7**

Time (Minutes)	0	10	20	30	40	50
Temp. (ºC)	40	46.5	51.7	55.7	58.9	61.1

Calculate the final steady temp. rise and the time constant of the machine. If the ambient temp. is 20ºC.

b) Derive the relation between mechanical overload ratio and heating overload ratio. **6**

OR

2. a) A transformer having temp. rise of 20ºC after 1 hour and 32ºC after 2 hours at continuous full load. **7**
1) What is the final steady state temp. rise on this load.
2) If transformer is work on 50% overload how long will it takes to obtain same temp.- given that copper losses on full load equal to twice iron loss.

b) Define: **6**
1) Heating time constant. 2) Cooling time constant
3) Steady state temp. rise while heating

3. a) Estimate the main dimensions of core, no. of turns and cross-sectional area of conductor of primary and secondary winding of a 300kVA, 11KV / 440V, 3-ϕ, Δ / γ connected core type 50Hz distribution transformer. The following data is given. **8**
Ratio of voltage per turn to square root of kVA rating is 0.45, winding space factor = 0.3, stacking factor = 0.9, Maximum flux density = 1.2 wb/m^2, current density = 2.5 A/mm^2 Hw/ww = 3, $A_i = 0.6\ d^2$.

b) Derive the expression for the width of the window of a transformer for optimum output. **6**

OR

4. a) What is the ideal cross-section of core? Why? Derive the ratio of net core area to area of circumscribing circle for two stepped core? **7**

b) Estimate flux density, main dimensions, no. of turns and area of cross-section of conductor for 3-ϕ, Δ / γ core type distribution transformer rated at 200 kVA, 11kV/440V 50Hz, A suitable core with two steps having circumscribing circle of 0.2m diameter and leg spacing of 0.3m is available. Assume Et = 6V, δ = 2.5 A/mm^2 kw = 0.29, SF = 0.9. **7**

5. A 15000 kVA, 33/6.6 kV, 3 – ϕ, γ – Δ core type transformer has the following data **13**
Net iron area of each limb = 150 x 10^{-3}m^2
Net Area of yoke = 180 x 10^{-3}m^2
Mean length of flux path in each limb = 2.3m
Mean length of flux path in each yoke = 1.6m
No. of turns in HV winding = 450
Calculate the no. load current. Use the following data.

Bm (wb/m^2)	0.9	1.0	1.2	1.3	1.4
MMF/metre (A/m)	130	210	420	660	1300
Iron loss (W/kg)	0.8	1.3	1.9	2.4	2.9

OR

6. Write short notes on **any three.** **13**
i) Properties of transformer oil.
ii) Off load Tap changer of transformer.
iii) Methods of cooling in case of transformer.
iv) CRGO and HRGO materials.

7. a) Estimate the main dimension, no. of stator conductors, conductor of cross section of a 100kW, 3300V, 50Hz, 12Pole, γ - connected slipring I. M. Assume Bar = 0.4 wb/m^2, ac = 25000 A/m, cos ϕ = 0.9, kws = 0.96, δ = 3.5 A/mm^2. Choose main dimensions to give best power factor. **7**

b) Define : **6**
1) Specific magnetic loading. 2) Specific electric loading.

OR

8. a) Estimate the main dimensions, airgap length, no. of stator slots, and cross sectional area of stator conductor for a 3 – ϕ, 20HP, 400V, 6 Pole, 50 Hz Induction Motor suitable for γ-Δ starting. Assume magnetic and specific electric loading as 0.45 wb/m^2 and 23000 ac/m respectively. **8**
Ratio of core length to pole pitch is 0.85, η = 88%, P.F = 0.89

b) Write short notes on selection of stator slots. **5**

9. Following design data are provided for 3- ϕ 4 pole, Δ-connected 10kW squirrel cage Induction motor: **13**
Stator bore diameter = 15 cm
Axial length of stator = 9cm
No. of stator slots = 36, ϕ m = 4.768 mwb
kws = 0.96, Stator current / phase = 11.53A
current density in bar and end rings is 5 and 6A/mm^2 respectively.
Length of rotor bar = 13 cm, $\rho = 2.1 \times 10^{-8}\,\Omega - \text{m}$.
Design suitable cage rotor giving bar and end ring dimensions. Also determine rotor speed.

OR

10. a) Discuss crawling and cogging in care of Induction motor. **5**

b) A 90kW, 500V, 50Hz, 3-ϕ, 8-pole induction motor has a star-connected stator winding accommodated in 63 slots with 6 conductors per slot. If the slip ring voltage on open circuit is to be about 400V, Design a suitable rotor winding, giving **8**

i) No. of slots.
ii) No. of conductors per slot
iii) Slip-ring voltage on open circuit.
iv) Approximate full load current / phase in rotor. Assume $\eta = 90\%, \cos\phi = 0.86$

11. a) Determine the main dimensions for a 1mVA, 50Hz, 3-ϕ, 375rpm alternator **7**
Bar = 0.55 wb/m^2, ac = 28,000 A/m
Use rectangular poles. Maximum permissible peripheral speed is 50 m/sec. The ran away speed is 1:8 times the synchronous speed suggest suitable pole construction.

b) What is effect of SCR on the performance of synchronous machine? **7**

OR

12. Write short notes on:

i) Advantages of hydrogen cooling. **5**

ii) Runaway speed of alternator. **5**

iii) Skewing of slots of induction motor. **4**

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