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

Electrical Machine Design

P. Pages : 4

NJR/KS/18/4475

Time : Three Hours

* 0 2 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) Derive the expression for the temperature rise of the machine when it is heated. **7**

b) During the heat run test of a 100 kVA transformer, the temperature rise after 1 hour and 2 hrs. is found to be 24ºC and 34ºC respectively. Calculate the heating time constant and final steady temperature rise. **7**
Calculate short time rating of machine.
If temperature rise not to exceed 60ºC after one hour on overload. Assume losses to be proportional to the square of the load.

OR

2. a) During a temperature rise test at full load on a 100 kVA transformer, temperatures recorded were 60ºC after 1 hour and 72ºC after 2 hours. Find the time for which the transformer may safely be loaded to 200 kVA. Ambient temperature is 40ºC and full load copper loss (at 100 kVA) is twice the iron loss. **7**

b) Heat run test on a d.c. motor give the following results : **7**

Time (min)	0	15	30	45	60	75
Temp (Degc)	50	56.6	61.8	65.8	69	71.2

Calculate the final steady temperature rise and heating time constant if ambient temperature is 30 Deg.c.

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

b) Calculate the main dimensions of 125 kVA, 6.6 kV|400V, 50 Hz, single phase shell type transformer Assume : **7**
Voltage per turn = 10 V
Flux density in core = 1.1 wb/m^2
Current density = 2 A/mm^2

Window space factor = 0.33
Stacking factor = 0.9

Ratio of $\frac{\text{Height of window}}{\text{Width of window}} = 3$

Ratio of $\frac{\text{Depth}}{\text{Width of central limb}} = 2.5$

Also calculate number of turns and area of cross-section of conductors.

OR

4. a) With reference to transformers, write short notes on : **6**

i) Choice of Flux Density.
ii) Choice of Current Density.

b) Determine the main dimensions of the core, the number of turns and the area of conductors for a 5 kVA, 50 Hz 11000/400V, 1-phase core type distribution transformer. The net conductor area in the window is 60% of the net cross-section (square) of the iron core. Assume a flux density of 1 wb/m^2, a current density of 1.4 A/mm^2 and a window space factor of 0.2. The window height is 3 times its width. **7**

5. Write short notes on **any three.** **13**

i) Properties of Transformer oil.

ii) Continuous and short time Rating.

iii) Classification of Insulating Material.

iv) Need of stepped core cross section.

OR

6. a) A 300 kVA, 6600/400V, 50Hz delta/star 3-phase core type transformer has the following data. **6**
Width of H.V. winding = 25mm, width of L.V. winding = 16mm, Height of coils = 0.5m, length of mean turn = 0.9m, H.V. winding turns = 830. Width of duct between H.V. and L.V. winding = 15mm.

i) Calculate the leakage reactance of the transformer referred to H.V. side.
ii) If the L.V. coil is split into 2 parts with one part on each side of H.V. coil, calculate the leakage reactance referred to H.V. side. Assume that there is a duct 15mm wide between H.V. winding and each part of L.V. winding.

b) Calculate the no-load current of a 400V, 50Hz 1-ph. core type transformer, the particulars of which are as follows. Length of mean magnetic path = 200cm, gross core section = 100cm^2; Joints equivalent to 0.1mm air gap; Maximum flux density = 0.7 Tesla; Specific core loss at 50Hz and 0.7 Tesla is 0.5 watts per kg; Ampere turns 2.2 per cm for 0.7 Tesla; Stacking factor = 0.9; Density of core material = 7.5 x 10^3 kg/m^3. **7**

7. a) Derive an output equation of 3 phase induction motor. **6**

b) 3 phase, 250HP, 400V, 50Hz, 4 pole slip ring delta connected induction motor has following data : **7**
Efficiency = 0.92, power factor = 0.88
Current density = 3.5 A/mm^2
Diameter at air gap = 395 mm
Net iron length = 316 mm
Flux per pole = 59 mwb
Flux density in stator core = 1.3 wb/m^2
Calculate slot dimensions, stator copper loss and outside diameter of stator laminations.
Resistivity of copper = 2.1 x 10^{-8} Ωm
Maximum flux density in stator teeth = 1.7 wb/m^2.

OR

8. a) Find the main dimensions, number of stator turns, size of conductor and number of stator slots of a 5 H.P., 400V, 3-phase, 50Hz, 1500 syn. r.p.m., squirrel cage induction motor, star-delta starting is used. Use the following data. **8**
Average flux density in the air gap = 0.46 wb/m^2.
Ampere conductor per meter of armature periphery = 22000.
Full load efficiency = 83%, full load power factor = 0.84 lagging.
Current density δ = 3.5 A/mm^2
Stator winding factor = 0.955
Ratio of core length to pole pitch = 1.2.

b) Explain the factors affecting choice of number of stator slots. **5**

9. a) State factors affecting selection of air gap length in case of 3ϕ Induction motor. **6**

b) 15 KW, 400 V, 3 phase, 50 Hz, 6 pole, induction motor has a diameter of 0.3 m and length of core 0.12m, The number of stator slots is 72 with 20 conductors per slot. The stator is delta connected. Calculate value of magnetising current per phase if length of air gap is 0.55mm. The gap contraction factor is 1.2. **7**
Assume the mmf required for the iron parts to be 35% of the air gap mmf. coil span = 11 slots.

OR

10. a) Explain the phenomena of crawling of 3-phase induction motor. **5**

b) The following design data are provided for an induction motor. Calculate **8**
i) no load maximum flux.
ii) length of air gap.
iii) Number of turns per phase.
iv) Rotor bar current and area.
v) End ring current and area.
vi) Losses in bars and end rings.
Diameter of stator bore = 15cm, Length of stator core = 9 cm.
Average flux density = 0.45 Tesla, Efficiency = 84%, Power factor = 0.86.
3 phase, 4 pole, 400 V, delta connected 10 KW,
Frequency = 50 Hz, Stator slots = 36, Rotor slots = 30.
Length of rotor bar = 15 cm. Mean diameter of end ring = 12 cm.
Current density of rotor bar = 6 A/mm^2.
Current density of end rings = 7 A/mm^2.

11. a) Explain the short circuit Ratio of synchronous machine. Discuss the effect of SCR on machine performance. **7**

b) Design the suitable values of diameter and length of a 75 MVA, 11 KV, 50 Hz, 3000 rpm, 3 phase, Y-connected alternator. Also determine the value of flux, conductors per slot, number of turns per phase and size of armature conductor. **7**

Given :

Average gap density = 0.6 Tesla

Average ampere conductor per meter = 50,000

Winding factor = 0.95

Current density = 6 A/mm^2

Peripheral speed should not exceed 180 m/s.

OR

12. Write short notes on :

a) Effect of SCR on performance of alternator. **5**

b) Pitch factor and distribution factor. **4**

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

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