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Question Paper Code : 20486

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

Sixth Semester

Electrical and Electronics Engineering

EE 8002 — DESIGN OF ELECTRICAL APPARATUS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish lap and wave winding.

2. Classify magnetic materials and name few of them used in the design of electrical machines.

3. Why distribution transformers are designed to have maximum efficiency at loads quite lower than full load?

4. Give the empirical formulae to find window space factor based on operating voltage and kVA.

5. List the advantages and disadvantages of having more number of poles while designing DC machines.

6. Give the factors which decide the specific electric loading of DC machine.

7. Write the formula for AT of air gap of induction motor.

8. Write the steps involved in the slip ring rotor design.

9. What is short circuit ratio? Give the range for high and low speed alternators.

10. Write the types of windings used in synchronous machines. List their advantages and disadvantages.

PART B — (5 × 13 = 65 marks)

11. (a) Give a broad classification of insulation materials used in the electrical machine design. (13)

Or

(b) Draw a simplex, progressive lap winding having 16 slots, 4 pole DC generator having 16 coils. Mark the emf direction and position of brushes. (13)

12. (a) Derive the output equation of transformer. Compare the gross area if core is square and cruciform. (13)

Or

(b) Determine the dimensions of the core and yoke for a 100 kVA, 50 Hz single phase core type transformer. A square core is used with distance between the adjacent limbs equal to 1.6 times the width of the laminations. Assuming V/T of 14 volts, maximum flux density 1.1 Wb/m^2, window space factor 0.32, current density 3A/mm^2. Take stacking factor as 0.9, flux density in the yoke to be 80% of flux density in core. (13)

13. (a) Derive the expression for P_a for small motor and generator. List the factors on which the number of poles depend upon. (13)

Or

(b) Find the main dimensions, number of poles and length of air gap of a 1000 kW, 500 V, 300 rpm DC generator. Assume specific electric loading of 40,000 and magnetic loading of 0.7Wb/m^2, square pole face, ratio of pole arc to pole pitch is 0.7. Assume efficiency as 92% and gap contraction factor as 1.15. (13)

14. (a) Derive the output equation of three phase induction motor. Also state why circle diagram is not valid for induction motor with deep bar rotor. (13)

Or

(b) Draw circle diagram to find various performance parameters of induction motor. Also prove that the value of over load capacity decreases with increase in the value of dispersion coefficient. (13)

15. (a) Prove from first principles that the output q of a synchronous machine is given by , kVA= $C_0D^2Ln_s$.

Obtain the expression for C_o. Show that the volume of the rotor of a three-phase synchronous machine having sinusoidally distributed winding is given by, $V = Q.10^3/(2\sqrt{2}\, B_m . ac . n_s . K_w)$. (13)

Or

(b) Calculate the diameter, core length, number of conductors of the stator, size of conductor, number of stator slots of a 30MVA, 11kV, 3000 rpm, 50 Hz star connected turbo alternator. Assume the following data : $B_{av} = 0.55$ Wb/m^2, ac = 55,0000 A/m, $K_w = 0.955$, $v_s = 160$ m/sec. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A 1000 kVA, 6600/440V , 50 Hz, 3 phase delta/star, core type ON cooled transformer has the design data as follows:

Distance between centers of adjacent limbs 0.47 m, outer diameter of hv winding 0.44m, height of frame 1.24m, core loss 3.7 kW, I^2R loss 10.5kW. Design a suitable tank with tubes for the transformer. The average temperature rise of oil should not exceed 35 degree Celsius. The specific heat dissipation from the tank walls is 6W/m^2/degree Celsius and 6.5 W/m^2/degree Celsius due to radiation and convection respectively. Assume that heat dissipation is improved by 35%due to convection. (15)

Or

(b) (i) Show that the dimensions of a DC machine depend upon the work done per revolution and not on the kW output.

The various losses of a 60 HP, 220 V, 850 rpm DC motor are as follows:

Copper loss = 3.2 kW, core loss = 0.8 kW, mechanical loss = 0.1 kW

(ii) For another DC machine otherwise similar to this machine but having its linear dimensions 1.5 times, estimate approximately :

(1) total copper, core and mechanical losses

(2) HP rating and efficiency

Justify our calculations. (15)