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Question Paper Code: 1056167

B.E. / B.Tech. DEGREE EXAMINATIONS, NOV/ DEC 2024
Sixth Semester
Electrical and Electronics Engineering
EE8002 - DESIGN OF ELECTRICAL APPARATUS
(Regulation 2017)

Time: Three Hours Maximum: 100 Marks

Answer ALL questions

PART – A (10 x 2 = 20 Marks)

1. Classify the properties of magnetic materials.

2. Deduce the concept of total electric loading.

3. Justify the preference for circular coils in transformers.

4. The voltage per turn of a 500KVA, 11KV, Δ/Y three phase transformer is 8.7V.Calculate the number of turns per phase of LV and HV windings.

5. Clarify why square pole face is preferred.

6. State the relationship between the number of commutator segments and number of armature coils in dc generator.

7. Analyze how an induction motor can be designed for optimal power factor.

8. Why is the length of air gap in an induction motor kept at minimum possible range?

9. How is cylindrical pole different from salient pole in a synchronous machine?

10. List the factors that govern the design of field system of alternator.

PART – B (5 x 13 = 65 Marks)

11. (a) (i) Explain in detail about major considerations in electrical machine design. (6)
(ii) A single-phase transformer core is made of silicon steel with a relative permeability of 1000. The core has a mean length of 1 m and a cross-sectional area of 0.01 m^2. If the magnetizing current is 2 A, determine the number of turns required to achieve a flux density of 1.5 T. (7)

(OR)

(b) Develop a diagram of a simple 2-layer lap-winding for a 4-pole generator with 16 coils. (13)

12. (a) Determine the main dimensions of the core of a 5kVA, 11000/400V, 50Hz, 1 phase core type distribution transformer. The net conductor area in the window is 0.6 times the net cross section area of iron in the core. The core is of square cross section, maximum flux density is 1Wb/m^2. Current density is 1.4A/mm^2. Window space factor is 0.2. Height of the window is 3 times its width. (13)

(OR)

(b) A 3 phase, 50Hz, oil cooled core type transformer has the following dimensions: Distance between core centers=0.2m , height of window =0.24m, Diameter circumscribing Circle =0.14m. The flux density in the core =1.25Wb/m^2, the current density in the conductor =2.5 A/mm^2. Assume a window space factor of 0.2 and the core area factor =0.56. The core is two stepped. Estimate KVA rating of the transformer. (13)

13. (a) Identify the main dimensions of the machine for a 500 kW,250V, 4 pole, 1500 rpm shunt generator is designed to have a square pole face. The loadings are: average flux density in the gap=0.42Wb/m^2 and ampere conductors per meter=15000. Assume full load efficiency 0.87 and ratio of pole arc to pole pitch=0.66. (13)

(OR)

(b) Determine the air gap length of the DC machine from the following particulars: gross length of the core =0.12, number of Ducts = one and 10mm wide, slot pitch=25mm, slot width =10mm, carter's coefficient for slots and ducts =0.32, gap density at pole center =0.7Wb/m^2; field mmf/pole =3900AT, mmf required for iron parts of magnetic circuit =800AT. (13)

14. (a) (i) What are the advantages of squirrel cage induction and slip ring induction motors? (3)

(ii) Design a cage rotor for a 18.8HP, 3phase, 440V, 50Hz, 1000rpm, induction motor having full load efficiency of 0.86, power factor = 0.86, D=0.25m, L=0.14m, Z_{ss}/S_s= 54. Assume missing data if any. (10)

(OR)

(b) Identify the main dimension, air gap length, stator slots, slots/ phase and cross sectional area of stator and rotor conductors for three phase, 20HP, 400V, 6 pole, 50Hz, 975 rpm induction motor. The motor is suitable for star – delta starting. B_{av} = 0.45 wb/m^2. ac = 20000 AC/m, L / τ = 0.85. η = 0.9 , P.F = 0.85. (13)

15. (a) A 1000kVA, 3300V, 50Hz, 300rpm, 3-phase alternator has 180 slots with 5 conductors/ slot, single layer winding with full pitched coil is used. The winding is star connected with 1 circuit per phase. Determine the specific electric and magnetic loading, if the stator bore is 2.0m and the core length is 0.4m. Using the same loading determine corresponding data for a 1250kVA, 3300V, 50Hz, 250rpm, 3-phase star connected alternator having 2 circuit per phase. The machines have 60^0 phase spread. (13)

(OR)

(b) Determine the main dimensions of a 75000 KVA, 13.8KV, 50Hz, 62.5rpm, 3 phase star connected alternator. The peripheral speed is about 40m/s. Assume average gap density=0.65wb/m2, ampere conductors/metre= 40,000 and current density=4A/mm2. Also find the no. of stator slots, conductors per slot, conductor area. Assume slot pitch= 55mm. (13)

PART – C (1x 15 = 15 Marks)

16. (a) (i) Describe the design procedure for the field winding of a salient pole synchronous machine. Include steps for estimating the air-gap length and determining the damper winding design. (8)

(ii) A 250 kW, 6-pole synchronous motor has damper bars that are made of aluminum. The damper winding is subjected to an average current of 300 A. The permissible current density for aluminum is 2.5 A/mm^2.

Determine:

(a) The minimum cross-sectional area of each damper bar.

(b) The number of damper bars required per pole, assuming the total cross-sectional area per pole is 1200 mm^2. (7)

(OR)

(b) Write a computer program to design the slip-ring rotor of a three-phase induction motor. The program should calculate:

- The rotor's main dimensions (diameter and length).
- The number of rotor slots.
- The rotor winding parameters, including conductor size and current density.
- The equivalent resistance and reactance of the rotor circuit.

Assume the following data for the motor:

15 kW, 400 V, 50 Hz, Number of poles = 4

Efficiency = 90%, Power factor = 0.85

Air gap flux density (Bav)) = 0.45 T, Ampere-conductor loading (A) = 25000 A/m

Include user inputs for other necessary parameters, such as the stacking factor and specific loadings. (15)

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