CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. List and explain the factors to be considered during the design of electrical machines. **(08 Marks)**

b. List and explain the limitations in design. **(08 Marks)**

c. Explain the Modern Machine Manufacturing Techniques. **(04 Marks)**

OR

2 a. List the different types of materials used in electrical machines. Explain the classification of insulating materials. **(10 Marks)**

b. What is design and why design is required? **(04 Marks)**

c. List the additional factors to be considered while designing electrical machines. **(06 Marks)**

Module-2

3 a. Derive an expression for the output equation of a DC machine. **(10 Marks)**

b. A design is required for a 50 KW, 4 pole, 600 rpm, dc shunt generator, with a terminal voltage of 220 V. If maximum gap density is 0.83 Wb/m^2 and the armature ampere conductors/meter are 30,000. Calculate the suitable dimensions of armature core to give a square pole face. Assume that full load armature voltage drop is 3% of rated terminal voltage and that of field current is 1% of rated full load current. Ratio of pole arc to pole pitch is 0.67. **(10 Marks)**

OR

4 a. List and explain the factors to be considered while selecting number of poles of a DC machine. **(06 Marks)**

b. Show that the output of a DC generator with single turn coil is given by the expression $P' = \frac{0.03E'VqA}{PN}$ kW where E′ = Average voltage between adjacent commutator segment, V = peripheral speed of generator in m/sec. **(10 Marks)**

c. What are the advantages of large number of poles in a D.C. machine? **(04 Marks)**

Module-3

5 a. Derive an expression for output equation of single phase transformer. **(10 Marks)**

b. Find the main dimensions of a core and window for a 500 KVA, 6600/400 V, 50 Hz, 1ϕ, transformer. Assume the flux density of 2.75 A/mm^2. Window space factor is 0.32, volt/turn is 16.8 Volts. Use cruciform core section. Height of the window is 3 times its width. Also find cross sectional area of primary and secondary winding. **(10 Marks)**

OR

6 a. Calculate the no load current for 11000/400 V, 50 Hz, 1ϕ, core type transformer. If mean length of magnetic path is 300 cm, gross iron area of the core 150 cm^2, maximum flux density is 1.2 Tesla, core loss/kg of iron is 3.3 Watts. Ampere turns/metre of the transformer iron is 800, density of iron is 7.5 g/cc. Stacking factor of iron is 0.95 and joints are equivalent 0.1 mm of air gap. **(12 Marks)**

b. Derive an expression for output equation of a three phase transformer. **(08 Marks)**

Module-4

7 a. Discuss the various factors that affect the choice of the length of air gap of an induction motor. **(08 Marks)**

b. Determine the diameter and length of stator core of a 70 HP, 415 V, 3ϕ, 50 Hz, star connected, 6 pole induction motor. The specific electric and magnetic loadings are 32000 Ampere conductors/metre and 0.51 Wb/m^2. Take efficiency as 90% and power factor as 0.91. Assume number of slots/pole/phase as 3 and pole pitch is equal to core length. Estimate the number of stator conductors required for the winding in which conductors are connected in two parallel paths. Choose a suitable number of conductors/slot so that the slot loading does not exceed 750 Ampere-conductor. Take slot pitch as 1.5 to 2.5 cm. **(12 Marks)**

OR

8 a. With a neat diagram, explain the crawling and cogging of an induction motor. **(10 Marks)**

b. Discuss in detail the calculation of no load current of a 3 phase induction motor. **(10 Marks)**

Module-5

9 a. Derive an expression for output equation of a three phase synchronous machine. **(10 Marks)**

b. Determine suitable dimensions for a 500 kVA, 50 Hz, 3ϕ, alternator to run at 375 rpm. Mean gap density over a pole pitch is 0.55 tesla and specific electric loading is 250 ampere conductor/cm. The pheripheral speed not to exceed 30 m/sec. Assume armature winding is full pitched with a phase spread of 60°. Take $\frac{L}{\tau}$ ratio as 1. **(10 Marks)**

OR

10 a. With a graph, explain short circuit ratio and explain the effect of SCR on machine performance. **(08 Marks)**

b. A 3 phase, 30 pole, 3.3 KV, Y connected salient pole alternator is designed to supply a rated current of 130 A, with average flux density of 0.55 Tesla. The specific electric loading is 3000 Ampere conductors/metre. If the conductors/slot is 9 and slots/pole/phase is 2, find kVA rating of alternator, main dimensions, width of parallel slots, if the flux density in tooth is 1.8 Tesla. Take K_p as 1, $K_W = 0.955$ and ratio of $\frac{L}{\tau}=5$. Also take stacking factor as 0.9, n_v as 4 and b_v as 1 cm. **(12 Marks)**

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