CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, Dec.2024/Jan.2025
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. What are the limitations in design? **(06 Marks)**

b. What are the desirable properties of conducting materials? **(06 Marks)**

c. What are the desirable properties of magnetic materials? Explain in brief magnetic materials and classification. **(08 Marks)**

OR

2 a. Classify the insulating materials used in electrical machines, according to their thermal stability. Give one example for each. **(10 Marks)**

b. What are the desirable properties of insulating materials? **(06 Marks)**

c. Write short notes on cold rolled grain oriented steel used in electric machines. **(04 Marks)**

Module-2

3 a. Define specific electric and magnetic loadings of DC machines. What are the merits and demerits of selecting higher values of specific loadings? **(08 Marks)**

b. A 100 KW, 500 V, 6-pole, 450 rpm DC shunt motor having the following data. Armature diameter 0.54 m, Length 0.245 m, average flux density 0.55 wb/m^2, efficiency 89%. Armature voltage drop is 5% of rated voltage and field current is 1% of line current. Diameter of commutator is 0.65 of armature diameter. Check for the following :
The slot loading should not exceed 1500 A commentator pitch should not be less than 4 mm. pole arc to pole pitch ratio 0.66. **(12 Marks)**

OR

4 a. Discuss the various factors which govern the choice of number of poles in DC machine. **(08 Marks)**

b. Determine the main dimensions, number of poles and length of air gap of a 600 KW, 500 V, 900 rpm DC generator. Assume average flux density 0.6 wb/m^2 and ampere conductors per meter as 35000. The ratio of pole arc to pole pitch is 0.75 and efficiency is 91%. The mmf required for air gap is 50% of armature mmf and gap contraction factor is 1.15. **(12 Marks)**

Module-3

5 a. Derive the output equation of single phase and 3-phase core type transformers. **(10 Marks)**

b. Determine the main dimensions of a 200 KVA, 50 Hz single phase core type transformers. A cruciform core is used. The distance between the core centers is equal to 1.6 times the width of the core laminations. Assume volt/turn = 14 V, maximum flux density is 1.1 wb/m^2, current density = 3 A/mm^2. Net iron area = 0.56 d^2. Width of largest stamping is 0.85 d. Window space factor = 0.27. **(10 Marks)**

OR

6 a. Explain the procedure to calculate the no load current of a single phase transformer and 3-phase transformer. **(10 Marks)**

b. A 250 KVA, 6600/400 V, 3-phase core type transformers has a total loss of 4800 W at full load. The transformer tank is 1.25 m in height and 1 m × 0.5 m in plan. Calculate the total number of tubes, if the temperature rise is limited to 35°C. The diameter of the tube is 50 mm and the height of the tube is 1.05 m. Specific heat dissipation due to convection and radiation is 6 and 6 w/m^2 °C respectively. Assume that convection is improved by 35/- by the provision of tubes. **(10 Marks)**

Module-4

7 a. With usual notations, derive the output equations of a 3-phase induction motor. **(08 Marks)**

b. Determine the main dimensions, turns/phase number of slots, conductor cross section and slot area of a 250 Hp, 3ϕ, 50 Hz, 400 V, 1410 rpm slipring induction motor. Assume B_{av} = 0.5 wb/m^2, a_c = 30000 A/m, power factor = 0.9, efficiency = 0.9, winding factor = 0.955, current density = 3.5 A/mm^2. The ratio of core length to pole pitch is 1.2. The slot space factor 0.4, the machine is delta connected. **(12 Marks)**

OR

8 a. What are the factors to be considered while deciding the length of air gap in induction motor? Mention few formula for estimating the air gap length. **(08 Marks)**

b. 11 KW, 3-phase, 6-pole, 50 Hz, 220 V, star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the value of bar and end ring currents. The number of rotor bar is 64. The machine has an efficiency of 0.86 and a power factor of 0.85. The rotor mmf may be assumed to be 85% of stator mmf. Also find the bar and end ring sections if the current density is 5 A/mm^2. **(06 Marks)**

c. Derive the equation for end ring current of induction motor. **(06 Marks)**

Module-5

9 a. Derive the output equation of a synchronous machine. And show the equation interms of peripheral speed. **(10 Marks)**

b. Find the main dimensions of a 2500 KVA, 187.5 rpm, 50 Hz, 3-phase, 3 KV, salient pole synchronous generator. The specific magnetic loading 0.6 wb/m^2 and specific electric loading 34000 ac/m. Use circular poles with ratio of core length to pole pitch is 0.65. Specify the type of pole construction used if the runaway speed is about 2 times the normal speed. Winding factor is 0.955. **(10 Marks)**

OR

10 a. What is SCR of a synchronous machine? What are the effects of SCR on machine performance? **(10 Marks)**

b. During the design of stator of a 3-phase 7.5 MVA, 6.6 KV, 50 HZ, 3000 rpm, Start star connected generator, the following data is obtained. Diameter of stator = 0.75 m, Length = 0.9m, number of slots/pole/phase = 7, sectional area of conductors = 190 mm^2, number of conductors per slot = 4. Based on the above data calculate the following :

i) Flux/pole ii) B_{av} iii) a_c iv) current density. Winding factor 0.955 **(10 Marks)**

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