CBCS SCHEME

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18EE55

Fifth Semester B.E. Degree Examination, July/August 2021
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions.***
2. ***Assume any missing data suitably.***

1 a. What do you mean by Design of Machines? What are the major considerations to evolve a good design? **(06 Marks)**

b. With the help of a neat sketch, explain the basic structure of an electromagnetic rotating machine. **(07 Marks)**

c. What are the fundamental requirements of high conductivity materials? **(07 Marks)**

2 a. Discuss the factors which limit the design of a machine. **(10 Marks)**

b. Explain the classification of Insulating materials for electrical machinery is relation to their thermal stability. Give two examples for each class. **(10 Marks)**

3 a. What are the main dimensions in design of rotating machines? What do you mean by specific magnetic and specific electric loadings? **(05 Marks)**

b. Develop the output equation of a DC machine. **(05 Marks)**

c. Find the main dimensions of a 200kW, 250V, 6 pole, 1000rpm generator. The maximum value of flux density in the gap is 0.87wb/m^2 and the ampere conductors per meter of armature periphery are 31000. The ratio of pole arc to pole pitch is 0.67 and the efficiency is 91 percent. Assume the ratio of length of core to pole pitch = 0.75. **(10 Marks)**

4 a. What are the guiding factors for choice of number of poles in DC machines? **(04 Marks)**

b. What are the factors to be considered for selecting the number of armature slots? **(06 Marks)**

c. Find the main dimensions and number of poles of a 37kW, 230V, 1400rpm shunt motor so that a square pole face is obtained. The average gap density is 0.5wb/m^2 and the ampere conductors per meter are 22,000. The ratio of pole arc to pole pitch is 0.7 and the full load efficiency is 90 percent. **(10 Marks)**

5 a. Develop the output equation for a single phase as well as a three phase transformer. **(06 Marks)**

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 of circumscribing circle = 0.14m. The flux density in the core is 1.25wb/m^2 and the current density in the conductors is 2.5A/mm^2. Estimate the KVA rating. Assuming a window space factor of 0.2 and a core area factor = 0.56. The core is two stepped. **(06 Marks)**

c. Explain how the temperature rise and the number of cooling tubes of the transformer are calculated. **(08 Marks)**

6 a. Prove that EMF/turn of a single phase transformer is $K\sqrt{Q}$ where Q = output KVA rating of transformer. **(04 Marks)**

b. Show that the ratio of Net core area to area of circumscribing circle is i) 0.58 for square core ii) 0.71 for stepped or cruciform core. **(06 Marks)**

c. The tank of a 1250KVA natural oil cooled transformer has the dimensions length, width and height as 1.55m × 0.65m × 1.85m respectively. The full load loss is 13.1kW. Find the number of tubes for this transformer assuming W/m^2 - °C due to radiation = 6 ; W/m^2 - °C due to convection = 6.5, Improvement is convection due to provision of tubes = 40 percent temperature rise = 40°C ; length of each tube = 1m ; diameter of tubes = 50mm. Neglect to top and bottom surfaces of the tank as regards cooling. **(10 Marks)**

7 a. What are the main dimensions of Induction motor? What are the desired values of L/τ, peripheral speed and width of ventilation ducts? **(05 Marks)**

b. Discuss the factors to be considered for selection of number of slots for the stator of induction motor. **(05 Marks)**

c. Determine the approximate diameter and length of the stator core, the number of stator slots and the number of conductors for a 11kW, 400V, 3 phase, 4 pole, 1425 rpm delta connected Induction motor. Adopt a specific magnetic loading of 0.45 wb/m^2 and a specific electric loading of 23,000 A/m. Assume full load efficiency and power factor as 0.85 and 0.88 respectively. The ratio of core length to pole pitch is 1. The stator employs a double layer winding. **(10 Marks)**

8 a. With usual notations, derive the output equation for a three phase induction motor. **(06 Marks)**

b. What are the factors to be considered when estimating the length of air gap in a induction motor. **(07 Marks)**

c. A 11kW, 3 phase, 6 pole, 50Hz, 220V, star connected induction motor has 54 stator slots, each containing 9 conductors. Calculate the values of bar and end ring currents. The number of rotor bars is 64. The machine has an efficiency of 0.86 and a power factor of 0.85. The rotor mmf may be assumed as 85 percent of stator mmf. Also find the bar and the end ring sections of the current density is $5A/mm^2$. **(07 Marks)**

9 a. Derive the output equation of the synchronous machine. **(06 Marks)**

b. Discuss the factors to be considered for the selection of armature slots is synchronous machines. **(07 Marks)**

c. Determine for a 500KVA, 50Hz, 3 phase alternator to run at 375rpm. Take mean gap density over the pole $0.55wb/m^2$, the specific electric loading as 25,000A/m. The peripheral speed should not exceed 35m/s. **(07 Marks)**

10 a. What are the factors to be considered for choice of specific magnetic loading and specific electric loading of synchronous machines? **(06 Marks)**

b. Define SCR of a synchronous machine. Discuss the effects of SCR on machine performance. **(06 Marks)**

c. The field coils of a salient pole alternator are wound with a single layer winding of base copper strip 30mm deep, with separating insulation 0.15mm thick. Determine a suitable winding length, number of turns and thickness of conductor to develop an mmf of 12000A with a potential difference of 5V per coil and with a loss of $1200w/m^2$ of total coil surface. The mean length of turn is 1.2m. The resistivity of copper is $0.021\Omega/m$ and mm^2. **(08 Marks)**

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