CBCS SCHEME

USN | | | | | | | | | | 15EE64

Sixth Semester B.E. Degree Examination, Dec.2019/Jan.2020
Electrical Machine Design

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Assume any missing data suitably.***

Module-1

1 a. What are limitations involved in design of electrical machines? **(06 Marks)**

b. What are the desirable properties of conducting materials? **(05 Marks)**

c. What are ferromagnetic materials and solid core materials? **(05 Marks)**

OR

2 a. Compare aluminium and copper wires. **(04 Marks)**

b. What are the desirable properties of insulating materials? Give the classification of insulating materials based on thermal consideration with two examples in each class. **(08 Marks)**

c. What is cold rolled grain oriented silicon steel? What are advantages of using these materials in electrical machines? **(04 Marks)**

Module-2

3 a. Define "specific magnetic loading" and "specific electric loading". What are advantages and disadvantages of using higher specific loadings? **(08 Marks)**

b. Find the main dimensions and number of poles of a 50HP, 230V, 1400rpm shunt motor so that a square pole is obtained. Specific magnetic loading in the air gap is 0.5 weber/m^2 and the ampere conductors per are 22,000. The ratios of pole arc to pole pitch is 0.7. Assume the efficiency as 90%. Check that the obtained values are within permissible limits. Take 1 HP = 0.7355KW. **(08 Marks)**

OR

4 a. What are the advantages and disadvantages of large number of poles in d.c. machines? **(06 Marks)**

b. Calculate the diameter and length of armature for a 7.5kW, 4 pole, 1000rpm, 220V shunt motor. Given that the full load efficiency is 83%. Maximum air gap flux density is 0.9 webers/m^2. Specific electric loading is 30,000 ampere conductors per meter, field form factor is 0.7. Assume that the maximum efficiency occures at full load and field current is 2.5% of rated current. The pole face square. **(10 Marks)**

Module-3

5 a. Prove that EMF /turn of a single phase transformer is $K\sqrt{Q}$ where Q = output KVA rating of transformer per phase. **(06 Marks)**

b. The tank of a 1250 KVA natural oil cooled transformer has the following dimensions, length width and height as 0.65m, 1.55m and 1.85m respectively. The full load loss is 13.1 kW. Assume heat dissipation due to convection as 6.5W/m^2 °C and due to radiation as 6.0W/m^2 °C. Improvement in convection due to provision of tubes is 40%. Limit for temperature rise is 40°C. Length of each tube is 1.0m and diameter of each tube is 50mm. Find number of tube to be provided for the transformer. Neglect top and bottom surfaces of the tank as regards cooling. **(10 Marks)**

OR

6 a. Derive the output equation of a three phase core type of transformer. **(06 Marks)**

b. Determine the dimensions of core, the number of turns, the cross section area of conductors of primary and secondary windings of a 100KVA, 2200V/480V single phase core type of transformer to operate at a frequency of 50Hz by assuming the following data :
Approximate volts per turn = 7.5V, maximum flux density is 1.2 weber/m^2. Ratio of effective cross section area of core to the square of the diameter of circumscribing circle is 0.6, Ratio of height to width of window is 2.0, window space factor K_w = 0.28, current density $\delta = 2.5A/mm^2$. **(10 Marks)**

Module-4

7 a. Derive the output equation of a three phase induction motor. **(06 Marks)**

b. Determine the main dimensions, turns per phase number of slots, conductor cross section and slot area of a 250HP, 3 phase, 50HZ, 400V, 1410 rpm, slip ring induction motor. Assume specific magnetic loading, B_{av} = 0.5T, specific electric loading, ac = 30,000 ampere conductors per meter, efficiency is 90%, winding factor is 0.955, current density = 3.5 A/mm^2. The slot space factor is 0.4 and ratio of core length to pole pitch is 1.2. The machine is delta connected. Take 1 HP =0.7355 kW. **(10 Marks)**

OR

8 a. What are the factors to be considered for estimating the length of air gap for induction motors? Explain them. **(06 Marks)**

b. Estimate the stator dimensions, number of stator slots, and number of stator conductor per slot for a 100kW, 3300V, 50Hz, 12 pole, star connected slip ring induction motor. Assume an average flux density of 0.4 webers/m^2 in the air gap, ampere conductors per meter as 25,000, efficiency is 90%, power factor = 0.9 and winding factor = 0.96. Choose main dimensions to give best power factor. The slot loading must not exceed 500 ampere conductors. **(10 Marks)**

Module-5

9 a. Derive the output equation of a synchronous machine in terms of its main dimensions and specific loadings. **(06 Marks)**

b. Find the main dimensions of a 100MVA, 11KV, 50Hz, 150rpm, 3 - phase, water wheel driven alternator. The average air gap flux density is 0.65 webers/m^2 and ampere conductors per meter are 40,000. The peripheral speed should not exceed 65m/sec at normal running speed in order to limit the runaway speed. Assume a winding factor K_{ws} = 0.955. **(10 Marks)**

OR

10 a. Define Short Circuit Ratio (SCR) of a synchronous machine and discuss its effects on the

b. machine performance. **(08 Marks)**

c. Determine the main dimensions of a 1000KVA, 50Hz, 3-phase, 375 rpm alternator. The average air gap flux density is 0.55 webers/m^2 and the ampere conductors per meter are 28,000. Use rectangular poles and assume a winding factor K_{ws} = 0.955. Bolted on pole construction is used for which the maximum permissible peripheral speed is 50 meters/sec. The runaway speed is 1.8 times the synchronous speed. **(08 Marks)**

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