CBCS SCHEME

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15EE64

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

Time: 3 hrs. Max. Marks: 80

Note:1. ***Answer any FIVE full questions.***
2. ***Missing data, if any may be suitable assumed.***

1 a. What are the factors that impose limitations on design of electrical machines? **(08 Marks)**

b. Mention and explain the important features of modern manufacturing techniques in design of electrical machine. **(08 Marks)**

2 a. Mention the fundamental requirements for high conducting materials used in manufacturing of electrical machines. **(04 Marks)**

b. What is cold rolled grain oriented steel and why it is used in electrical machines. **(06 Marks)**

c. Classify the insulating materials used in electrical machines based on thermal considerations. **(06 Marks)**

3 a. Discuss the various factors, which govern the choice of number of poles D.C machines. **(06 Marks)**

b. A 4 pole, 25HP, 500V, 600RPM series motor has an efficiency of 82%. The pole faces are square and the ratio of pole are to pole pitch is 0.67. Assuming and average gap density of 0.55wb/m^2 and armature ampere conductors per meter as 17,000. Obtain the main dimensions of the core number of armature conductors and number of slots. **(10 Marks)**

4 a. Calculate the apparent flux density at a section of the teeth of an armature of a D.C machine from the following data at the section.
Slot pitch = 24mm, Slot width = 12mm, length of armature core including 5 ducts 10mm each = 0.38mt, Iron stacking factor = 0.92. flux density in teeth at that section is 2.2Wb/m^2 for which the mmf is 70,000 A/m. **(06 Marks)**

b. A field coil of a D.C machine is to produce on mmf of 7000A when dissipating 220W at a temperature of 60°C and specific dissipation is 30W/m^2-°C from the outer surface neglecting top and bottom of the coil. The length of the inner most layer is 0.68mt and the coil 0.15mt high. Temperature of ambient air is 20°C. Calculate the thickness of the coil, space factor and the current density. The resistivity of conductors is 0.02Ω/mt/m^2. **(10 Marks)**

5 a. Derive the output equation of a three phase transformer and explain the choice of specific magnetic and electric loadings. **(10 Marks)**

b. Design the suitable number of cooling tubes necessary for a 3 phase transformer having the following particulars:
KVA rating = 500, efficiency = 98% at 0.88 p.f, Heat dissipation = 12.5W/m^2/°C. Tank dimensions = 48 × 96cm × 150cm height. Assume the diameter of cooling tubes as 6cm and average height is 120cm. Temperature rise to be limited to 35°C. **(06 Marks)**

6 a. Derive the expression for leakage reactance of core type transformer with respect to primary side. State the assumption made. **(06 Marks)**

b. Calculate : i) Net cross section of core ii) Gross area of core iii) Core dimensions iv) Window area v) Dimensions of the window for 200KVA, 6600/350V single phase shell type oil immersed, self cooled, distribution transformer based on the following design parameters. Window space factor = 0.28 ; Window proportion = 2.5:1, Maximum flux density in the core = 1.1wb/m^2, Average current density = 2.2A/mm^2 ; Assume stacking factor = 0.9 ; Rectangular core proportion = 1.8:1. Net cross section of copper in the window is 0.2 times net cross section of iron in the core. **(10 Marks)**

7 a. Discuss the factors to be considered while deciding the length of the air gap and number of stator slots. **(06 Marks)**

b. For a 20HP, 400V 3ϕ, 960RPM, squirrel cage Induction motor to be started by a Y-Δ starter. Find the dimensions of the diameter, length, number of slots, area of slot, turns per phase and cross section of the conductor of the stator. Specific magnetic loading = 0.4 wb/m^2. Ampere conductors/cm of the stator periphery = 240. Efficiency = 86%, power factor = 0.85, winding factor = 0.945. **(10 Marks)**

8 a. Derive an expression for the rotor bar current and end ring current is a 3-phase squirrel cage rotor, with sketch. **(08 Marks)**

b. A 15kW, 400V, 3ϕ, 50Hz, 6 pole induction motor has a diameter of 0.3mt and length of core 0.12mt. The number of stator slots is 72 with 20 conductors/slot. The stator is delta connected. Calculate the value of magnetising current per phase if the length of air gap is 0.55mm. The gap contraction factor 1.2. Assume the mmf required for the iron parts to be 35% of the air gap, Coil span = 11 slot **(08 Marks)**

9 a. Define short circuit ratio in connection with 3 phase synchronous generator. Explain the factors affected by SCR. **(08 Marks)**

b. The following is the design data available for a 1250KVA 3 phase, 50Hz, 3300V, star connected 300rpm alternator of salient pole type. Stator bore diameter = 1.9mt, stator core length L = 0.335mt, pole are to pole pitch ration is 0.66m, turns per phase = 150, single layer concentric winding with 5 conductors per slot, short circuit ratio = 1.2. Assume that the distribution of gap flux is rectangular under the pole are with zero values in the inter poles region. Calculate: i) Specific magnetic loading ii) armature mmf per pole iii) Gap density over pole arc iv) Air gap length. MMF required for oil gap is 0.88 of no-load field mmf and the gap contraction factor is 1.15 **(08 Marks)**

10 a. From first principle derive the output equation of a 3 phase alternator, what are the usual values of specific loadings. **(08 Marks)**

b. Find the main dimensions of a 100MVA, 11KV, 50Hz, 150RPM. 3-phase water wheel generator. The average gap density is 0.65wb/m^2, and ampere conductors per mt are 40,000. The peripheral speed should not exceed 60m/sec at normal running speed in order to limit the run-away peripheral speed. **(08 Marks)**

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