CBCS SCHEME

USN

18EE55

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Electrical Machine Design

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Describe the modern trends in electrical machine manufacturing industries. **(10 Marks)**
b. What are the fundamental requirements of high conducting materials? **(07 Marks)**
c. What are the classification high resistivity materials according to their purpose? **(03 Marks)**

OR

2 a. Explain the classification of magnetic material related to the value of permeability and distinguish between soft and hard magnetic materials. **(06 Marks)**
b. Describe the classification of insulating materials based on their thermal consideration. **(08 Marks)**
c. List out the desirable properties of magnetic materials. **(06 Marks)**

Module-2

3 a. Explain the specific loadings of D.C. machine and what are advantages and disadvantages of higher values of specific loadings (Base & q). **(08 Marks)**
b. Determine the external diameter and gross core length of armature for a 7.5kW, 220V, 1000rpm shunt motor. Select he number of poles considering the frequency of flux reversal $\ngtr$ 50Hz. Assume average gap density as 0.63wb/m^2, ampere conductors per metre as 30000, ratio of pole arc to pole pitch is 0.7 and the friction windage and iron loss to be 600watts. Check the design for following constraints peripheral speed < 15m/s, armature mmf per pole < 2500. Considering the maximum gap density, $B_q = B_{avg}/0.75$ and mmf required for air gap is 60% of armature mmf and gap contraction factor is 1.15 calculate air gap length. **(12 Marks)**

OR

4 a. Explain the factors to be consider for selecting the number of poles of D.C. machines and write any three advantages of higher values of number of poles of D.C. machine. **(08 Marks)**
b. Design a 4 pole, 10kW, 220V, 1000rpm, d.c. shunt motor, giving following details:
i) The diameter and length of armature
ii) Number of armature conductors
iii) Number of slots
iv) Size of conductor
Assume following design data:
Specific magnetic loading = 0.45T, specific electric loading = 17500 amp cond/m, ratio of pole arc to pole pitch = 0.68, slot pitch = 2.2cm, constant losses = 8% of output, armature voltage drop = 10% of terminal voltage armature is wave wound. **(12 Marks)**

Module-3

5 a. Derive the following design equations for a 3-phase transformer, relating the output to the specific loading and main dimensions, i) EMF per turn ii) Output equation. **(08 Marks)**

b. Design the magnetic frame of 3-phase 250kVA, 6600/400 volts, 50Hz, core type distribution transformer with respect to the following: i) Core section ii) Diameter of circumscribing circle iii) Window area iv) Dimensions of window v) Yoke section and flux density in yoke vi) Yoke dimensions.
Assume; cruciform core section with $A = 0.56d^2$ and a = 0.85d, the constant K, in emf per turn is 0.45, maximum flux density in core is 1.2 wb/m^2 and current density is 2.2A/mm^2, the window space factor = 0.3, the ratio of window height to width = 3, yoke section is 10% higher than core section. **(12 Marks)**

OR

6 a. Explain the design of tank with cooling tubes for the transformer, giving the equation to calculate number of tubes to limit temperature rise. **(10 Marks)**

b. Calculate the active and reactive component of no-load current of a 15000kVA, 33.3/6.6kV, 3-phase, star-delta, core type transformer having following data:
net iron area of each limb = 0.15m^2 net iron area of yoke = 0.18m^2, Mean length of each limb = 2.3m, mean length of each yoke = 1.6m, number of turns in h.v. winding = 450. Take maximum flux density same for both limb and yoke, as = 1.2wb/m^2. At this flux density, ampere-turns per meter of the material is 420 AT and specific iron loss is = 1.9w/kg, density = 7.8×10^3kg/m^3 Neglect mmf for joints. **(10 Marks)**

Module-4

7 a. Discuss the factors that affect the
i) Choice of average flux density in air gap
ii) Choice of ampere conductors per meter in the design of 3-phase Induction Motor. **(08 Marks)**

b. Determine the main dimensions, turns per phase number of slots, conductor cross section and slot area of a 250h.p, 3-phase, 50Hz, 400V 1410rpm, slip-ring induction motor. Assume B_{av} = 0.5 wb/m^2, ac = 30000A/m, efficiency = 0.9 and p.f = 0.9, winding factor = 0.955, current density = 3.5A/mm^2, slot space factor is 0.4 and ratio core length to pole pitch = 1.2 take 5 slots per pole per phase motor is delta connected. **(12 Marks)**

OR

8 a. Explain the step-by-step procedure of wound rotor design. **(08 Marks)**

b. During the stator design of a 3-phase, 50Hz, 30kW, 400V, 6 pole, squirrel cage induction motor, the following informations were obtained gross length = 0.17m, internal diameter = 0.33m, number of slots = 45, number of conductors per slot = 12, stator winding is star connected based on above, design a cage rotor giving i) diameter of rotor ii) number of rotor slots iii) rotor bar current iv) size of rotor bar v) end-ring current and section of end ring. Assume: p.f. = 0.86, efficiency = 0.88, k_w = 0.955 current density in bar = 6A/mm^2; current density in end ring = 6.5A/mm^2, take length of air gap = 0.67mm. **(12 Marks)**

Module-5

9 a. Derive the output equation of synchronous machine, that relates output to main dimensions. **(08 Marks)**

b. Determine the main dimensions, number of stator slots, conductors per slot, and conductor area of a 75000kVA, 13.8kV, 50Hz, 187.5rpm, 3-phase, star connected synchronous alternator peripheral speed should be about 60m/sec. Assume average flux density = 0.65wb/m^2, ampere conductors per meter = 40,000 and current density = 6A/mm^2, k_w = 0.955, number of slots per pole per phase = 2.5. **(12 Marks)**

OR

10 a. Define Short Circuit Ratio (SCR) and its effect on machine performance. **(10 Marks)**

b. A 3000rpm, 50Hz, 3-phase, turbo alternator has a core length of 0.94m, the average gap density = 0.45wb/m^2, and ampere conductors per meter = 25000. The peripheral speed of rotor is 100m/s, and length of air gap is 20mm. Find kVA output of the machine when

i) Winding factor k_w = 0.955

ii) Winding factor k_w = 0.827

What is the relation between winding factor and kVA output. **(10 Marks)**

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