Roll No. :

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7E4177

B.Tech. (Sem. VII) (Main) Examination, January - 2010
Electrical Engineering
(7EE6.2 Computer Aided Design of Electrical Machines)

Time : 3 Hours] [Total Marks : 80
[Min. Passing Marks : 24

Attempt overall five questions. All questions carry equal marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used / calculated must be stated clearly.)

Use of following supporting material is permitted during examination.
(Mentioned in form No. 205)

1. Nil 2. Nil

1 (a) What is meant by main and performance specifications of Electrical Machines. Write main and performance specifications for three-phase transformer.

(b) Write the main factors affecting the design of electrical machines. What are the limitations imposed on design of Electrical Machines ?

(c) Explain what is meant by real and apparent flux density. Derive the equation for the relation between real and apparent flux density.

4+4+8

OR

1 (a) Define specific electric and specific magnetic loadings of electrical machines.
A 350 kW, 500 V, 450 r.p.m. 6-pole dc generator is built with an armature of 0.87 meter and a core length of 0.32 meter. The lap wound armature has 660 conductors. Calculate the specific electric and magnetic loadings.

(b) Write short notes on :
(i) Insulating materials and
(ii) Graphical method of finding mmf for tapered teeth.

8+8

2 (a) Derive the equation for temperature rise of an electrical machine with time during its running. What is meant by heating time constant of machine?

(b) Explain, what is meant by continuous rating, short time rating and intermittent rating of electrical machines.
An induction motor has a final steady temperature rise of 40°C when running at its rated output. Calculate its half hour rating for the same temperature rise if the copper losses at rated output are 1.25 times its constant losses. The heating time constant is 90 minutes.

8+8

OR

2 (a) Derive the equation for mean temperature rise of an electrical machine during its intermittent heating.

(b) Explain why the hydrogen cooling is used for large turbo alternators.

(c) Define cooling time constant of an electric machine and draw its cooling-time curve.

8+4+4

3 (a) What are the functions of conservator and breather in transformer ? Explain.

(b) Derive the output equation for a three-phase transformer.

(c) Explain, why distribution transformers are designed to have maximum efficiency at or near 50% load while power transformers are designed to have maximum efficiency at or near full load.

4+8+4

OR

3 (a) Distinguish between power and distribution transformer.

(b) Explain with neat sketches the following types of windings used in these phase core type transformer.
(i) Cylindrical
(ii) Cross over
(iii) Helical and
(iv) Disc.

(c) Find the main dimensions of core for a 50 Hz, 200 kVA, 6600/500 volts, star/delta core type transformer. Use the following data:
Core limb section to be 4-stepped
Window space factor = 0.27
(Height of window) / (width of window) = 2
Current density = 2.8 A/mm^2
Voltage per turn = 8.5
maximum flux density = 1.25 Web/m^2.

4+4+8

4 (a) Explain the term "Short circuit ratio" and its effects on the performance of synchronous machines.
Show that the short-circuit ratio (SCR) of synchronous machines is inversely proportional to its synchronous reactance.

(b) Design the main dimensions of a 75 MVA, 11 kV, 50 Hz, 3000 rpm 3-phase, star connected alternator. Also determine the value of flux per pole, turns per phase, and size of armature conductors. Given that
Average flux density = 0.6 Web/m^2
Specific electric loading = 50000 ac/meter
Peripheral speed = 180 m/sec.
Winding factor = 0.95
Current density = 6A/mm^2.

8+8

OR

4 (a) Give reasons why a turbo alternator has smaller diameter and larger length whereas a water wheel generator has large diameter and smaller length.

(b) Discuss the factors which influence the selection of the specific magnetic and electric loadings in design of synchronous machines.

(c) Determine the main dimensions of a 3000 kVA, 6.6 kV, 50 Hz, 187.5 r.p.m. 3-phase, star connected alternator. Also find the turns per phase. Given that
Average flux density = 0.58 Web/m^2
Specific electric loading = 35000 ac/meter
Pole-arc to pole-pitch ratio = 0.7

4+4+8

5 (a) Deduce the output equation of a 3-phase induction motor in terms of its specific loadings. Why the length of airgap in induction motor is kept as minimus as possible ?

(b) Calculate diameter and length of stator core, and number of turns per phase of a 3-phase, 120 kW, 2200 volts, 750 rpm (synchronous speed), 50 Hz, star connected slip ring induction motor. Given that:
Average flux density in air gap = 0.48 Web/m^2,
Specific electric loading = 26000 ac/meter,
Efficiency = 92%, Power factor = 0.88
Winding factor = 0.955, Current density = 5 A/mm^2,
Pole arc to pole pitch ratio = 1.25.

8+8

OR

5 (a) Explain the phenomenon of crawling and coagging in case of squirrel cage induction motor.
Why in an induction motor, the number of starter slots should never be equal to the number of rotor slots.

(b) Estimate the stator core dimensions and stator turns per phase for a 100 kW, 3300 V, 50 Hz, 12 pole star connected slip ring induction motor. Given that:
Average gas density = 0.4 Web/m^2
Specific electric loading = 25000 ac/meter
Efficiency = 90%, Power factor = 0.9
Winding factor = 0.96
Design the machine for bee power factor.

8+8