C 44435 **(Pages : 3)** **Name**.....

Reg. No.....

SEVENTH SEMESTER B.TECH. (ENGINEERING) DEGREE [SUPPLEMENTARY] EXAMINATION, JUNE 2013

EE 09 704—ELECTRICAL MACHINE DESIGN

(2009 Admissions—Supplementary)

Time : Three Hours Maximum : 70 Marks

Part A

Answer **all** *questions.*

1. Write down the factors to be considered while selecting a suitable value of armature diameter.
2. Write down the equations for resistances of windings and the total resistance referred to primary side of a transformer.
3. Define short circuit ratio in synchronous machine and write the equation for the same.
4. Discuss on the design of slot dimensions in a synchronous machine.
5. Discuss on shapes of rotor slots in a squirrel cage IM.

(5 × 2 = 10 marks)

Part B

Answer any **four** *questions.*

6. Discuss on the pole design mentioning area of pole and height of pole in a d.c. machine.
7. Explain how the length of commutator is fixed in a d.c. machine.
8. Discuss the design of window dimensions and find out the window width for optimum output.
9. Calculate the kVA output of a single-phase transformer from the following data :

   core height / distance between core centres – 2.8

   $\frac{\text{diameter of circumscribing circle}}{\text{distance between core centres}} - 0.56$

   net iron area / area of circumscribing circle – 0.7

   current density – 2.3 A/mm^2,

   window space factor – 0.27,

   frequency – 50 Hz,

   flux density of core – 1.2 Wb/m^2,

   distance between core centres – 0.4 m.
10. Discuss on the effects of SCR on machine performance.
11. Discuss on the factors to be considered when estimating length of air gap for 3 phase induction motor.

(4 × 5 = 20 marks)

Turn over

Part C

12. Find the main dimension, number of poles and length of air gap of a 1000 kW, 500 V, 300 r.p.m. d.c. generator. Assume the specific magnetic loading B_{av} – 0.7 Wb/m^2, ampere conductor per meter – 40,000, square pole face, ratio of pole arc to pole pitch is 0.7. Assume efficiency as 92% and gap contraction factor as 1.15.

Or

13. The following particulars refer to the shunt field coil for a 440 V, 6 P d.c. generator. M.m.f. per pole – 7000 A, depth of winding – 50 mm, length of inner turn – 1.1 m, length of outer turn – 1.4 m, loss radiated from outer surface excluding ends – 1400 W/m^2, space factor – 0.62, resistivity – 0.02 Ω/m and mm^2.

Calculate :

(a) the diameter of wire,

(b) length of coil,

(c) number of turns, and

(d) exciting current.

Assume a voltage drop of 20 per cent of terminal voltage across the field regulator.

14. Determine the main dimensions of the core, the number of turns and the cross-section of the conductors for a 5 kVA, 11000/400 V, 50 Hz single-phase core type distribution transformer. The net conductor area in the window is 0.6 times the net cross-section of iron in the core. Assume a square cross-section of the core, a flux density of 1 Wb/m^2, a current density 1.4 A/mm^2, and a window space factor 0.2. The height of window is 3 times its width.

Or

15. A 250 kVA, 6600/400 V, 3ϕ core type transformer has a total loss of 4800 W at full-load. The transformer tank is 1.25 m in height and 1 m × 0.5 m in plan. Design a suitable scheme for tubes if the average temperature rise is to be limited to 35°C. The diameter of tubes is 50 mm and are spaced 75 mm from each other. The average height of tubes is 1.05 m. Specific heat dissipation due to radiation and convection is 6 and 6.5 W/m^2 –°C respectively. Assume that convection is improved by 35% due to provision of tubes.

16. Calculate the diameter, core length, number of conductors of the stator, size of conductor number of stator slots of a 30 mVA, 11 kV, 3000 r.p.m., 50 Hz star connected turbo alternator. Assume the following data :

B_{av} = 0.55 Wb/m^2, a.c. = 55000 A/m, K_w = 0.955 peripheral velocity = 160 m/s.

Or

17. The following data for a 1250 kVA, 0.8 p.f. 50 Hz, 3300 V, 300 r.p.m., star connected alternator is available. Stator turns / ph – 150, field turns / pole – 60, Effective area / pole – 0.09 m^2, air gap length at pole centre – 5 mm, field current for full-load short circuit current – 80 A, ATs per pole for iron portion – 20% of air gap. Assuming sinusoidal flux distribution, estimate the values of short circuit ratio and synchronous reactance.

18. Estimate the main dimensions, air gap length no. of stator slots, stator turns/ph and cross-sectional area of stator conductors for a 3 ϕ 20 h.p., 400 V, 6 pole, 50 Hz, 970 r.p.m. IM suitable for star delta starting. Assume magnetic and electric specific loadings as 0.45 Wb/m^2 and 23000 ac/m respectively, ratio of core length to pole pitch 0.85, full-load efficiency – 0.88 and power factor 0.89.

Or

19. A 3-phase, 2 p, 50 Hz squirrel cage IM has a rotor diameter of 0.2 m and core length of 0.12 m. The peak density in the air gap is 0.55 Wb/m^2. The rotor has 33 bars, each of resistance 125 $\mu\Omega$ and a leakage inductance 2 μH. The slip is 6%. Calculate :

(a) the peak value of current in each bar ;

(b) rotor I^2R loss ;

(c) rotor output ; and

(d) torque exerted.

Neglect the resistance of end rings.

(4 × 10 = 40 marks)