USN | | | | | | | | | | |

06EE63

Sixth Semester B.E. Degree Examination, Dec.09/Jan.10
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: ***1.Answer any FIVE full questions, selecting at least TWO questions from each part.***
2.Use of design data handbook is permitted.

PART – A

1 a. Mention the desirable properties of electrical insulating materials. Also give the classification of insulation materials based on temperature with an example for each. **(10 Marks)**

b. Mention the important qualities of magnetic materials used in electrical machines. List the different magnetic materials used in electrical machines. **(05 Marks)**

c. Justify the statement. "The total weight of the iron parts in DC machines decreases with increase in number of poles". **(05 Marks)**

2 a. Determine the diameter and length of the armature core for a 55kW, 110 volts, 1000 rpm 4 pole shunt generator. Assume specific electric and magnetic loadings as 26000 Ac/m and $0.5\omega b/m^2$ respectively. The pole arc is about 70% of pole pitch and core length is about 1.1 times the pole arc. Allow 10 amperes for field current and 4 volts drop in the armature circuit. Also determine the suitable values for number of armature conductors and number of slots. **(10 Marks)**

b. Each pole of a DC shunt motor is required to produce 18000 Ampere-turns. The air gap flux per pole is 0.2 ωb and the flux density in the circular pole core is 1.5 $\omega b/m^2$. The leakage coefficient for the pole is 1.2. The field coil has a radial depth of 5 cm and can dissipate 0.07 watts/cm^2 of the outside cylindrical surface without overheating. The conductor is insulated with 0.1mm thick insulation. The voltage across each field coil is 60 volts. Estimate:

i) diameter of the field conductor and its space factor
ii) height of the field coil
iii) the exciting current. Field conductors arranged without bedding. **(10 Marks)**

3 a. What is window space factor? Find the width of the window for the optimum output of a transformer. **(10 Marks)**

b. Estimate the i) core area ii) window area and iii) conductor area of c/s and no. of turns of a three phase delta/star core type transformer rated at 300 kVA, 6600/440 volts 50 Hz. A suitable core with three steps having a circumscribing circle of 0.25m diameter and a leg spacing of 0.4m is available. The emf per turn is 8.5 volts. Assume current density=2.5A/mm^2, window space factor = 0.28 and stacking factor = 0.9. **(10 Marks)**

4 a. The tank of a 1250 kVA natural oil cooled transformer has the dimensions length, width & height as 1.55m, 0.65m & 1.85m respectively. The full load loss is 13.1kW. Find the number of cooling tubes for this transformer assuming loss dissipated due to radiation = 6.0 W/m^2 and that due to convection = 6.5 W/m^2. Improvement in convection due to provision of tubes=40%, temperature limitation = 40°C, length of the tubes = 1m, diameter of the tubes=5cm. Neglect top and bottom surfaces for cooling. **(10 Marks)**

b. A 15 MVA, 33000/6600 volts, 50 Hz, 3 phase star/delta core type transformer has the following data:
Net iron area of each limb = 1.5×10^3 cm^2, net area of yoke = 1.8×10^3cm^2 , mean length of the flux path in each limb = 2.3m, mean length of the flux path in each yoke = 1.6m, voltage per turn E_t = 42.44 volts. MMF required for the limb at the working flux density is 560AT/m and that for the yoke is 260 AT/m. Specific loss/kg of the material is 2.25W/kg. Calculate active end reactive components of no load current & the no load current. Determine flux densities in yoke & core. Density of steel = 7.8×10^3 kg/m^3. **(10 Marks)**

PART – B

5 a. With usual notations, derive the output equation of a three-phase induction motor. **(10 Marks)**

b. Determine the diameter of stator bore and core length of a 50 kW, 415 volts, 3 phase, 6 pole star connected induction motor for which the specific electric and magnetic loadings are 32000 Ac/m and 0.51 ωb/m^2 respectively. The machine is having an efficiency of 90% and the power factor is 0.91. Design the machine for best power factor. Estimate the number of stator conductors required for a winding in which the conductors are connected in two parallel paths. Also find the number of slots and suitable number of conductors/slots. **(10 Marks)**

6 a. Discuss the methods employed to reduce the effect of harmonics in selection of the combination of rotor & stator slots in induction motors. **(10 Marks)**

b. A 15kW, 420volts, 50Hz, 3 phase induction motor with a synchronous speed of 1000 rpm has a delta connected stator winding accommodated in 54 slots with 26 conductors per slot. If the slip ring voltage on open circuit is to be about 350 volts, design a suitable rotor winding giving the details of i) number of slots ii) number of conductors / slot iii) approximate full load rotor current/phase iv) size of the rotor slot. Assume efficiency as 0.91 and power factor as 0.91. **(10 Marks)**

7 a. Define short circuit ratio as applied to a synchronous generator. Explain the factors that are affected by the SCR during design of synchronous generators. **(10 Marks)**

b. A 1000 kVA, 3300 volts, 50 Hz, 300 rpm, 3 phase alternator has 180 slots with 5 conductors/slot. Single layer winding with full pitched coils are used. The winding is star connected with one circuit per phase. The stator bore diameter is 2.0m and the core length is 0.4m. The winding is having a 60° phase spread, with full pitched coils. **(10 Marks)**

8 a. Discuss any five factors to be considered in selection of number of slots in synchronous machines. **(10 Marks)**

b. The following particulars refer to a 1250 kVA, 3 phase, 3300 volts, 50 Hz star connected alternator running at 300 rpm. Stator bore diameter = 1900 cms, core length = 33.5 cms, number of ventilating ducts = 4 with 1 cm width each, number slots = 180, size of slots=13.5mm×53mm,air gap flux density = 0.576 ωb/m^2. Ampere conductors per cm of periphery = 331. Calculate

i) Flux density in stator teeth
ii) Cross section of the conductor
iii) Number of conductors per slot. **(10 Marks)**