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10EE63

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Electrical Machine Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What are the limitations in the design of electrical machines? Explain. **(06 Marks)**

b. Derive the output equation of a D.C machine. **(06 Marks)**

c. Determine the main dimensions and number of poles of a 1000kW, 500 volts, 450 RPM D.C generator. Assume the air gap density as 0.62 Tesla and ampere conductors per meter as 40,000. The ratios of pole arc to pole pitch is 0.65. The ratio of length to pole pitch is 0.75. Assume efficiency as 90% current per brush arm not to exceed 400 amperes and frequency of the reversals in the armature not to exceed 50Hz. **(08 Marks)**

2 a. The field coils of a D.C machine are wound with a single layer winding of bare copper strip 3 cm deep with a separating insulation 0.15mm thick. Determine a suitable winding length, number of turns and thickness of conductor to develop an mmf of 12000 ampere-turns with a potential difference of 5V/coil and with a loss of 1200 Watts /m^2 of total coil surface. The mean length of turn is 1.2m. **(10 Marks)**

b. Estimate the ampere turns per pole required for the air-gap of a 500V, 6 pole, 300 rpm, lap connected D.C machine. The armature core having 90 slots is 30cm long. The pole pitch is 50cm while pole arc is 33cm. The air gap length may be taken as 5mm. There are 16 conductors per slot of width 1.3cm. Assume 5 ventilating ducts, each 1cm wide. The carter's co-efficient is 0.66 and 0.72 for slot width/gap of 2.6 and 2.0 respectively. **(10 Marks)**

3 a. With neat sketch derive the expression for leakage reactance of core type transformer with respect to primary side. State the assumption made. **(12 Marks)**

b. A 100KVA, 200/400V, 50Hz, 1ϕ shell type transformer has the following particular; B_{max} = 1.1wb/m^2, current density = 2.2 A/mm^2, window area constant = 0.33, volt/turn =11, core is rectangular and stampings are 7cm wide. Height of window = 2 * width of window. Obtain :

i) Net iron area and Area of window

ii) Dimensions and weight of core. Specific gravity of Iron = 7.8 gm/cm^2. **(08 Marks)**

4 a. Derive output equation for a 3 phase transformer. **(10 Marks)**

b. A 15000KVA, 33/6.6kV, 3-phase, Y -Δ core type transformer has the following data : Area of cross section of core limb = 0.16m, Area of cross section of yoke = 0.17m. length of flux path in each limb 2.3m in each yoke is 1.6m ; number of turns in h.v winding = 450. AT/m in core leg is 540 AT/m and in yoke is 260 AT/m as obtained from magnetization curves. Loss per kg in iron is 2.6 Watts/kg in limb and 1.5 watts/kg in yoke. Density of iron is 7.8 g/c.c. Estimate the No-Load current/phase. **(10 Marks)**

PART – B

5 a. Explain the factors which influence the length of air gap of 3 – phase induction motor. **(08 Marks)**

b. Calculate : i) Diameter ii) Length iii) Number of turns per phase iv) Full load current and cross – section of conductors and v) Total I^2R loss of stator of 3ϕ, 120kW 2200 volts, 50Hz, 750rpm [synchronous speed], star connected slip ring Induction motor from the following data :
B_{av} = 0.48 Tesla, (ac) = 26000 ampere/mt, efficiency = 92%, power factor = 0.88. Assume $L = 1.25T_p$, winding factor =0.95, current density = 5A/mm^2 mean length of stator conductors = 0.75m, resistivity of copper $\rho = 0.021\Omega$/mt and mm^2. **(12 Marks)**

6 a. Explain crawling an cogging of induction motor. **(10 Marks)**

b. A 120 HP, 500V, 3ϕ, 50Hz, 8 pole induction motor has a star connected stator winding accommodated in 63 slots with 6 conductors per slot. If the slip ring voltage on open circuit is to be about 400V, find a suitable rotor winding stating
i) Number of slots ii) Number of conductors per slot iii) Coil span
iv) Slip ring voltage on open circuit v) Approximate full load current per phase in rotor. Assume efficiency = 0.9 and power factor = 0.86. **(10 Marks)**

7 a. From first principles derive the output equation of a 3 phase alternator. **(06 Marks)**

b. Define short circuit ratio in connection with 3 phase alternator. Explain the factors affecting the SCR. **(06 Marks)**

c. A 1250 KVA, 3phase, 50Hz, 3300V, start connected 300rpm salient pole alternator has the following data : Diameter = 1.9 mt ; length = 0.335 mt ; pole arc/pole pitch = 0.66. turns/phase = 150. Single layer winding with full pitched coils having 5 conductors per slot is used SCR = 1.2. Assume the distribution of gap flux is rectangular under the pole arc with zero value at inter-poler region. Determine :
i) Specific magnetic loading ii) Armature mmf per pole iii) Gap flux density over pole arc iv) current per phase v) length of air gap.
Assume gap contraction factor = 1.15 and Air gap mmf = 88% of no load field mmf. **(08 Marks)**

8 a. Explain the design procedure for designing the field winding of a salient pole alternator. **(10 Marks)**

b. A 2500KVA, 225 rpm, 3 phase, 60Hz, 2400V, Star connected salient pole alternator has the following data :
Stator bore diameter = 250cm, Core length = 44cm, Slots/pole/phase = $3\frac{1}{2}$, Conductors per slot = 4, Circuits per phase = 2, Leakage factor = 1.2, Winding factor = 0.95. The flux density in pole core is 1.5 wb/m^2, the winding depth is 3cm. the ratio of full load field mmf to armature mmf is 2, field winding space factor is 0.84 and the field winding dissipates 1800 Watts/m^2 of inner and outer surface without the temperature rise exceeding the limit. Leave 3cm for insulation, flanges and height of pole shoe along the height of pole.
Find :
i) The flux per pole
ii) Length and width of pole
iii) Winding height and
iv) Pole height **(10 Marks)**

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