B.E./B.TECH. Degree Examination, December 2020

Fifth Semester

EE16502-DESIGN OF ELECTRICAL APPARATUS

(Regulation 2016)

Time: Three hours Maximum : 80 Marks

Answer **ALL** questions

PART A - (8 X 2 = 16 marks)

1. How should the properties of strength and dielectric strength in insulating materials?
   a) High strength, low Dielectric strength b) Low strength, low Dielectric strength
   c) High strength, high Dielectric strength d) Low strength, high Dielectric strength
2. For a DC generator, given D = 0.35 m, L = 0.21 m, Coefficient of output = 108.5, efficiency = 0.9, speed = 1400 rpm. What is the output power of the DC generator?
   a) 65.12 W b) 72.35 KW c) 72.35 W d) 65.12 KW
3. What is the loss dissipated by tubes by convection, given area of the tubes = 3.5?
   a) 12.3 W per °c b) 2.51 W per °c c) 5.3 W per °c d) 30.8 W per °c
4. How is the transient short circuit current related with the air gap density?
   a)air gap density is directly proportional to the short circuit current
   b)air gap density is indirectly proportional to the short circuit current
   c)air gap density is directly proportional to the square of the short circuit current
   d)air gap density is directly proportional to the square of the short circuit current
5. What is the difference between real and apparent magnetic flux densities in rotating machines?
6. What is the range of specific magnetic loading & specific electric loading in dc machine?
7. Write the relation between core area and with of iron and copper for a single phase transformer.
8. Why wound rotor construction is adopted?

PART B - (4 X16 = 64 marks)

09. (a) A lap connected generator has the following particulars: No load voltage is 500V,gap length =0.5cm, pole pitch =0.5 m, pole arc =0.33m, armature core length =0.3m, speed 300rpm,width of the slot =1.3 cm , No of ventilating ducts=5,each 1.0 cm wide, Number of slots=90, conductors per slot =16, No of poles =6, Calculate the following (i) Useful flux (ii) Gap Co-efficient for slot (iii) Gap Co-efficient for duct (iv) Ampere turns required for the gap **(16)**

(OR)

(b) (i) Calculate the apparent flux density in the teeth of a dc machine when the real flux density is 2.15 wb/m, slot pitch =28mm, slot width =10 mm and the gross core length =0.35m. The number of ventilating duct is 4, each 10mm wide. The magnetizing force for a flux density of 2.15 wb/m^2 is 55000 A/m. The iron stacking factor is 0.9. **(10)**

(ii) The diameter and length of a 500kw,500v,455 rpm 6 pole, DC generator are 84 cm and 35 cm respectively. If it is lap wound with 660 conductors. Estimate the specific electric and magnetic loading. **(6)**

10. (a) A 500 kw,460v, 8 pole, 375 rpm compound generator has an armature diameter of 1.1m and a core length of 3.3m. Design a symmetrical armature winding, giving the details of equalizers. The ampere conductors per meter are 34000. The internal voltage drop is 4 percent of terminal voltage and the field current is 1 percent of output current. **(16)**

The ratio of pole arc to pole pitch is 0.7. The voltage between adjacent segments at no load should not exceed 15v and the slot loading should not exceed 1500A. The diameter of commutator is 0.65 of armature diameter and the minimum allowable pitch of segments is 4mm. Make other suitable assumptions.

(OR)

(b) Determine the main dimensions, number of poles and length of air gap of a 600KW, 500V, 900rpm DC generator. Assume average gap density as 0.6 Wb/m^2 and ampere conductors per meter as 35000. The ratio of pole arc to pole pitch is 0.75 and the efficiency is 9.1%. **(16)**

The following are the design constraints: Peripheral speed $\leq$ 40 m/s, frequency of flux reversals $\leq$ 50 Hz, Current per brush arm $\leq$ 400A and armature mmf per pole $\leq$ 7500 A.

The mmf required for air gap is 50% of armature mmf and gap contraction factor is 1.15.

11. (a) Calculate approximate overall dimensions for a 200KVA, 6600/440V, 50HZ, 3phase core type transformer. **(16)**

The following data may be assumed:

Emf per turn =10V

Maximum flux density =1.3 wb/m^2

Current density=2.5 A/mm^2, window space factor = 0.3

Overall height=Overall width

Stacking factor=0.9. (Yoke section is square cross section). Use a three stepped core.

For three stepped core:

Width of largest stamping =0.9d

Net iron area =0.6 d^2

Where d is diameter of circumscribing circle.

(OR)

(b) A 1250 KVA, 6600/440V, 50HZ, 3phase, Delta/Star, core type, oil immersed natural cooled (ON) transformer. **(16)**

The transformer tank has the dimensions width, length, and height as 0.62m x 1.52m x 1.9 m respectively. Core loss= 3.7KW and Copper Loss =10.5KW.

Design a suitable tank for the transformer. The Average Temperature rise should not exceed 45 °C

Loss dissipation due to radiations = 6 W / m^2/°C

loss dissipation due to convection =6.5 W /m^2/°C

improvement in convection due to provision of tubes =35%,

Length of each tube = 100 cm, diameter of tube = 5 cm.

Distance between the tubes 75mm. Also calculate if cooling tube arrangement is not provided what will be the θ temperature in a transformer.

12. (a) (i) Determine the main dimensions of a 3.7KW, 400V, 3phase, 4 poles, and 50HZ squirrel cage induction motor to be started by a star-delta starter. **(8)**

Assume average flux density in the gap 0.45 wb/m^2

Ampere conductors per meter 23000 A/m

Efficiency 0.85 and power factor 0.84.

Machines rated at 3.7KW, 4poles are sold at a competitive price and therefore choose the main dimensions to give a cheap design.

Assume winding factor = 0.955, Stacking factor=0.9

(ii) Compute main dimensions of a 15 KW, three phase, 400 volts, 50 HZ, 2810 rpm squirrel cage induction motor having efficiency of 88 % and full load power factor of 0.9. Assume specific magnetic loading equal to 0.5 wb/m^2 and specific electric loading equal to 25000 A/m. The rotor peripheral speed may be approximately 20 m/sec at synchronous speed. **(8)**

(OR)

(b) (i) Determine the main dimensions of a 1000 kVA, 50 Hz, three phase 375 rpm alternator. The average air gap flux density is 0.55 Wb/m^2 and ampere conductors per meter is 28000. Use rectangular poles and assume a suitable value for ratio of core length to pole pitch in order that bolted on pole construction is used for which the maximum permissible peripheral speed is 50 m/sec. The runaway speed is 1.8 times peripheral speed. **(8)**

Assume winding factor 0.96

(ii) The output co-efficient of 1250 kVA, 300rpm, synchronous generator is 200kVA/m^3-rps.Winding factor 0.955(a) Find the values of main dimensions of the machine if the ratio of length to diameter is 0.2. Also calculate the value of main dimensions if (b) specific electric loadings are decreased by 10 % each with speed remaining the same. (c) Speed is decreased to 150 rpm with specific loading remaining the same as in part (a). Assume the same ratio of length to diameter. Comment upon the results. **(8)**