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Question Paper Code : 70528

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023

Sixth Semester

Electrical and Electronics Engineering

EE 8002 – DESIGN OF ELECTRICAL APPARATUS

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the function of magnetic core in electrical machines?

2. Why sheet steel possessing higher silicon content is used in transformers while the sheet steel used in rotating machines has a lower silicon content?

3. Write the expression for core dimension for three phase core type transformer.

4. How much temperature rise, a transformer can withstand.

5. List the factors which decide the choice of specific magnetic loading.

6. Show the complete magnetic path in a sketch of a 4-pole dc machine.

7. Why is the over load capacity low when the machine is designed with a high specific electric loading?

8. Why the length of air gap in induction motor is kept minimum possible whereas in dc machine it is large?

9. Distinguish turbo alternators and water wheel generators.

10. Give the important considerations for the choice of type of slots, opem or semi closed for the stator winding of synchronous machines.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Compare the conducting properties of copper and aluminium as used in electrical machines and state their relative merits? (6)

(ii) What is the effect of using aluminium winding in place of copper on I^2R losses and core losses of a transformer? (7)

Or

(b) (i) Distinguish between Hot rolled and cold rolled steel sheets. (6)

(ii) Give the advantages of CRGO steel laminations over hot rolled steel laminations in transformers. Can the CRGO laminations be used in large rotating machine? Explain. (7)

12. (a) (i) Prove that, for minimum copper loss in the transformer windings, the current densities) in the primary (δ_P)and the secondary (δ_S) must be equal. (6)

(ii) Calculate the KVA out of a single phase transformer from following data: (7)

Height of window /Distance between core centres = 2.8

Dia of circumscribing circle/ Distance between core centres = 0.56.

Net iron area / area of circumscribing circle = 0.7

Current density = 2.3A/sq.mm

Window space factors = 0.27

Frequency = 50Hz

Flux density in core = 1.2 Wb/sq.m

Distance between core centres = 0.4m

Or

(b) (i) For a transformer, show that volts/turn = K $\sqrt{Q}$ where Q is rating in kVA. What are the factors on which the value of deends? Is it, ore for core type or shell type transformer? Explain. (6)

(ii) Calculate the value of magnetizing load current of a 415/70V, single phase 50Hz welding transformer. Net cross sections of the core and yoke are 85sq.cm and mean length of flux of path is 100 cm. Primary has 88 turns/coil with 2 coils in series. Use the following data for the core (7)

Flux density Wb/sq.m	H AT/cm	Loss W/kg
0.8	0.8	0.72
0.9	0.92	0.92
1.0	1.23	1.09
1.1	1.79	1.3
1.2	2.5	1.56
1.3	4.4	1.87

13. (a) Prove that power developed by armature Pa in a dc machine is given by $P_a = (2+2\eta)/3\eta$ for small generators and P_a-$(1+2\eta)/3\eta$ for small motors under the assumptions that friction, windage and iron losses amount to one third of the total losses. (13)

Or

(b) Show that the output of a dc machine with single turn coil is given by $P = 3\ a\ E\ \upsilon\ q\ /\ pN$, where a: number of parallel paths, E:average voltage between adjacent commutator segments, v : peripheral velocity in m/sec, q: specific electric loading in amp.conductors/cm, P : number of poles and N : speed in rpm. (13)

14. (a) Obtain the approximate core dimension of a 30 HP , 3 phase, 440 V, 50 Hz, 960 rpm induction motor using the following data: (13)

Specific magnetic and electric loadings 0.45 Wb/sq.m and 250 ac/cm, full load efficiency = 0.86, full load pf : 0.87

Assuming that its star winding is to be delta connected for normal running, also determine the number of stator turns and number of stator slots.

Or

(b) A 10 Hp, 6 pole induction motor has its maximum power factor of 0.82, that occurs at full load. Estimate the maximum power factors, if

(i) there is a reduction in the air gap of 25% (7)

(ii) the motor is rewound for 4 poles with the original air gap Neglect the reluctance of the iron path. (6)

15. (a) (i) Prove from first principles that the output of a synchronous machines is given by KVA = C_0D^2Lns

Obtain the expression for C_0 (7)

(ii) Show that the volume of the rotor of a three phase synchronous machine is given by Volume = $Q\times10^3 / 2\sqrt{2\pi}\ B_m\ ac\ n_s\ K_w$. (6)

Or

(b) A 1250 KVA, 3.3kV, 50 Hz, 3 phase, 300 rpm synchronous generator with concentric armature winding has the following design data: (13)

Average flux density 0.58 Wb/sq.m, ac 33000 ac/m, ari gap 5.5, SCR 1.2, number of turns in each filed pole 60, effective gap area 0.6 × actual area, peripheral speed 30 m/sec. Calculate stator core length, stator bore, turns per phase, air gap mmf, armature mmf per pole and filed current at rated voltage and no load.

PART C — (1 × 15 = 15 marks)

16. (a) Draw a developed diagram of a 4 pole, 15 slot double layer simplex wave winding for a dc generator. Indicated the position of brushes as well. (15)

Or

(b) Determine the dimension of core and yoke for a 200 KVA, 50 Hz single phase core type transformer. A cruciform core is used with distance between adjacent limbs equal to 1.6 times width of largest stamping. Assume voltage per turns as 14V, maximum flux density in core 1.1 Wb/sq.m, window space factor 0.32, current density 3A/sq.mm, stacking factor 0.9. (15)