Ref: Ex/PE/T//2023/216

Bachelor of Power Engineering 2nd Semester 1st Semester Examination 2023

Subject Electrical Generators and Transformers

Time 3 Hours (Use Separate Answer scripts for each Part) Full Marks 100

PART A (Marks 70)

1. Answer any **Seven** (CO1) 2x 7 =14

a) Why are laminations used in rotor core of dc generator?

b) What is the difference between shell type and core type 3 phase transformers?

c) Why air gap in DC generators should be very small?

d) Why for a single phase transformer the l.v. winding is placed closer to the core?

e) What is Buchholz relay?

f) What is the trade name of transformer oil?

.g) What are the different cooling methods of transformer?

h) What are the general materials by which commutator are made for dc generator?

i) State whether thin or thick wire should be used for shunt field of dc generator?

j)What are the different types of DC Generators ?

k)What are the different losses of a Transformer?

2. Answer any **Two** (CO2) 2 x 3 = 6

i) Define In rush Phenomenon in a Transformer

ii) Define Critical Resistance of a DC Generator

iii) Define Voltage Build up process of a DC Generator

iv) Define All Day Efficiency

3. Answer any **Four** (CO3) 3x 4 = 12

i) How Voltage Regulation of a I phase Transformer is done practically?

ii) Explain why the Savings of Copper in Auto Transformer in comparison to a Single Phase Transformer is more

iii) Estimate the power handled by Open Delta in Comparison to Closed Delta.

iv) Explain Demagnetizing Ampere Turns of a DC generator.

v) Explain why Parallel Operation of 1 Phase Transformers are required

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v) Explain the Circuit diagram of a Scott Connected Transformer

vi) Explain the process of commutation in DC Generator?

4. Answer any **Two** (CO4) 2x2 =4

a. Draw the equivalent Circuit of a 1 Phase Transformer

b. Name the Two Tests where form Equivalent Circuit parameters can be obtained

c. Draw the equivalent Circuit of a 3 Phase Transformer

d. Show that a Transformer is basically an Inductance.

5. Answer any **Five** (CO5) 2x 5 = 10

i) Derive the Condition of Zero Voltage Regulation

ii) Derive the formula for Cross-magnetising Ampere Turns for a DC Generator

iii) Derive the Expression of Induced EMF of a DC Machine

iv) Derive Condition of Maximum Efficiency of a 1 Phase Transformer

v) Derive the phasor diagram from the circuit for any two of the following transformer connections:

Dd6, Dy11, Yz6. Dz1

vi) Explain the Oscillating neutral for a three-phase transformer.
vii) Derive to show Scott Connection can be used for Three phase to Two Phase Conversion and vice versa

5. Answer any **Four** (CO6) 4x 6 =24

i) A 6-pole D.C shunt generator with 778 wave-connected armature conductors and running at 500 r.p.m. supplies a load of 14.5Ω resistance at terminal voltage of 250 V. The armature resistance is 0.28Ω and the field resistance is 250Ω. Find the armature current, the induced e.m.f and the flux per pole?

ii) A 8 pole, 148 A DC shunt generator has 480 conductors and is wave wound. Its field current is 2 A. Find the demagnetizing and cross-magnetizing amperes turns per pole at full load if

a) Brushes are on GNA,
b) Brushes are shifted from GNA by 5^0 electrical,

iii) The short-circuit tests on two single phase transformers gave the following results:
200 kVA: 3% rated voltage; rated current at 0.75 p.f. lag.
500 kVA: 4% rated voltage; rated current at 0.6 p.f. lag.
These two transformers are connected in parallel. How do they share a load of 560 KW at 0.8 p.f. lag?

iv)In a Scott connection, calculate the values of line currents on the three phase side, if the loads on 2 phase side are 300 kW and 400 kW, both at 125 V and 0.707 p.f. and the three phase line voltage is 3300 V. The 300 kW load is on the leading phase of the 2 phase side. Neglect the losses.

.v) The maximum efficiency of a 40KVA, 50Hz, 1100/415V single-phase transformer is 98% and occurs at 85% of full load at unity power factor. If the impedance is 7%, calculate regulation at full-load 0.85 power factor lagging.

vi) The daily variation of load on a 100 kVA transformer is as follows:
8.00 A.M to 1.00 P.M : 60 kW, 45 kVAr
1.00 P.M to 6.00 P.M : 85 kW, 60 kVAr
6.00 P.M to 1.00 AM : 30 kW, 30kVAr
1.00 A.M to 8.00 A.M : No Load
This transformer has no-load core loss of 300 watts and full load ohmic losses of 1150 watts. Determine the all-day efficiency of the transformer.

vii) A single phase two winding 120 kVA, 2000/200 V transformer is to be used an auto-transformer for stepping up the voltage from 2000 V to 2400 V. At rated load, the two-winding transformer has 2.5% loss, 3.5% voltage regulation and 4.5% impendence. Determine the following for the auto-transformer:
(a) voltage and current rating (b) kVA rating (c) percentage impedance (e) regulation

viii) A delta star, 6.6/0.4kV bank of three identical single phase transformers supplies a three phase balanced load of 600kVA at 0.8pf lagging and a single phase load of 80kW at unity p.f. between one line and neutral. Determine the magnitude of currents in each primary phase winding and in each input line. Ignore internal voltage drops and their no-load current.

ix) Transformers connected in open-delta supply four 25kW, 3-phase, 400V induction motors from an 11kV line. At full load, each motor has an efficiency of 95% and operates at 0.85p.f lagging.

a) Determine kVA rating of each of the two transformers and their turns ratio.
b) Determine the line currents on h.v and l.v sides. At what power factor is each transformer operating?
c) What is the real power supplied by each transformer?
d) What would be the available capacity, if a third transformer of same rating is used to form the closed delta?

x) A three phase step down transformer energized from 11kV, 50Hz source takes a line current of 25A from the supply mains. Calculate the output voltage, output current and output kVA for any two of the following connections: a) star/star; b) star/delta; c) delta/star; d) delta/delta; e) delta/zigzag.

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B.E. POWER ENGINEERING SECOND YEAR FIRST SEMESTER - 2023

Subject : Electrical Generators and Transformers **Part - II** (30 Marks)

Use Separate Answer scripts for each Part

Q1. Answer any two questions: 2×3

(a) Under what condition does the voltage regulation of synchronous generator become negative?

(b) Why OCC of a synchronous machine has a curved shape whereas the SCC is a straight line?

(c) Why it is advantageous to provide the field winding on the rotor and armature winding on the stator in case of large synchronous machines.

(d) Explain the effect of change in excitation on the operation of alternator on infinite busbar.

Q2. Define any two terms: 2×2

Distribution factor, Synchronous Reactance, Synchronizing Power, Armature Reaction Factor

Q3. Answer any two questions: 2×3

(a) Derive the expression for the power developed in a cylindrical rotor alternator. Draw the power versus angle characteristics.

(b) Deduce the expression for synchronizing power in alternator.

(c) Derive the voltage phasor equation of a salient pole alternator.

(d) For a cylindrical rotor alternator working at at lagging power factor, show that

$$\tan\delta = \frac{I_a\left(X_s\cos\theta - r_a\sin\theta\right)}{V_t + I_a\left(X_s\sin\theta + r_a\cos\theta\right)}$$

Q4. Answer two questions: 7×2

(a) A 2 MVA, 6 kV, 8 pole, 3-phase, 50 Hz, alternator having synchronous impedance of 20% is synchronized to 6 kV bus. Find the synchronizing power per mechanical degree of angular displacement at rated voltage and at full load 0.8 power factor lagging. Also find synchronizing torque for a 0.4° mechanical displacement.

(b) A 50 Hz 6 pole alternator has 36 slots. It has two layer windings with full pitch coils of 8 turns each. The flux per pole is 0.015 wb. Determine the induced emf if the coils are connected to form 3 phase star connected winding.

(c) A 3-phase synchronous generator has a direct-axis synchronous reactance of 0.8 pu and a quadrature-axis synchronous reactance of 0.5 pu. The generator is supplying full-load at 0.8 pf lagging at 1 pu terminal voltage. Calculate the power angle and the no-load voltage if the excitation remains unchanged.

(d) The effective resistance of a 2200 V, 50 hz, 440 kVA, single phase alternator is 0.5 ohm. On short circuit a field current of 4 A gives the full load current. The emf on open circuit for the same field current is 1160V. Find the synchronous reactance.