Ref: PE/PC/T/216/2024

B.E. Power Engineering 2nd Year 1st Semester Examination, 2024
Sub: Electrical Generators and Transformers

Time 3 Hours **Full Marks 100**

Use separate answer script for each Part

Part I

Full Marks: 70

Answer **Any Four** of the following (**CO1**) **(4×2=8)**

Q1. a) What is Hysteresis Loss?

b) What is critical resistance in case of a DC generator?

c) What is HRS and CRGOS?

d) Why are laminations used in rotor core of DC generator?

e) What is rush current for 3 phase transformers?

f) Why is the condition of correct polarity most important and essential condition for parallel operation of Transformer?

Define **Any Four** terms of the following (**CO2**) **(4×2=8)**

Q2. i) All Day efficiency of Transformer (ii) Leakage Flux of Transformer (iii) Magnetic Neutral Axis (iv) Commutation of DC Machines(v) Voltage Regulation of Transformer (vi) Eddy Current Loss (vii) Critical Speed

Answer **Any Three** of the following (**CO3**) **(3×3=9)**

Q3. a) What is Single Phasing in case of a Three phase Transformer?

b) Draw phasor diagrams and circuit diagrams for the following transformer connections: Yz0, Dy11, Yd6

c) How armature reaction is controlled in between polar region in DC generator?

d) Why does the secondary terminal voltage changes in a Transformer as it is loaded?

e) How Sludging can be minimised?

f) Why distribution transformer should be designed with low loss?

g) State the Conditions of Parallel Operation of Single Phase Transformers

Answer **Any Two** of the following (**CO4**): **(2×4=8)**

Q4. a) How tertiary winding is represented in equivalent circuit of a Three Phase Transformer

b) Draw the circuit diagram of a Short Circuit Test in case of a Transformer

c) Find the savings of copper in case of a auto transformer in comparison to a two-winding transformer

d) Show that, from an exact equivalent circuit, transformer is an inductance

Answer **Any Three** of the following (**CO5**): **(3×3=9)**

Q5. a) Show that if two transformers have same p.u. impedances, then they will share a load in proportion to their kVA ratings.

b) If E is the induced emf, n is the speed in r.p.s, P is the number of poles, Z is the total number of armature conductor, Φ is the flux in Wb/pole and a is the no. of parallel paths, then derive the expression of induced emf in DC generators.

c) Derive the condition of Maximum Efficiency of a Single Phase Transformer.

d) Show that Two transformers on open delta can be used to supply three phase power

e) Show that for a Scott Connection, the neutral divides the teaser primary in 2:1 ratio.

[Turn over

Answer **Any Four** of the following (**CO6**): **(4×7=28)**

Q6. a) A compensated DC machine has 15,000 armature ampere turns per pole. The ratio of pole arc to pole pitch is 0.68. Interpolar air gap length and flux density are respectively 1cm and 0.25teslas. For rated armature current of 850A, calculate the compensating winding conductors per pole and the number of turns on each interpole.

Q6. b) Find the flux per pole of a 60kW DC generator having 4 poles, and a Wave wound armature with 300 conductors. The machine is running at a speed of 750rpm and generates 440V. Resistance of the armature and shunt fields are 0.75 ohm and 200 ohms respectively. Find the current flowing through the armature at full load and the terminal voltage.

Q6. c) A 2000kW, 400V, 14-pole DC machine has a lap wound armature with 1100 conductors. The pole arc to pole-pitch ratio is 0.7. Compute the number of pole-face conductors of the compensating winding in each pole, so as to obtain uniform air-gap flux density under the pole faces

Q6.d) The short-circuit tests on two single phase transformers gave the following results:
200 kVA: 3% rated voltage; rated current at 0.25 p.f. lag.
500 kVA: 4% rated voltage; rated current at 0.3 p.f. lag.
These two transformers are connected in parallel. How do they share a load of 800 KW at 0.85 p.f. lag?

Q6.e) A single phase two winding 220 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:
(i) voltage and current rating (ii) kVA rating (iii) efficiency

Q6.f) The O.C and S.C test data are given below for a single phase, 15 kVA, 200V/400V, 50Hz transformer.

O.C test from LV side : 200V 1.25A 175W

S.C test from HV side : 25V 10A 200W

Draw the equivalent circuit of the transformer referred to LV side inserting all the parameter values

Q6.(g) Transformers connected in open-delta supply four 40 kW, 3-phase, 440V induction motors from an 11kV line. At full load, each motor has an efficiency of 95% and operates at 0.90 p.f lagging.

i) Determine kVA rating of each of the two transformers and their turns ratio.
ii) Determine the line currents on H.V and L.V sides. At what power factor is each transformer operating?

Q6.(h) The maximum efficiency of a 40KVA, 50Hz, 1100/445V single-phase transformer is 96% and occurs at 90% of full load at unity power factor. If the impedance is 5%, calculate regulation at full-load 0.95 power factor lagging.

Q6 (i) A delta star, 11/0.44 kV bank of three identical single phase transformers supplies a three phase balanced load of 1000kVA at 0.85pf lagging and a single phase load of 90kW 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 no-load current.

Ref. No. : Ex/PE/PC/B/T/216/2024

B.E. POWER ENGINEERING SECOND YEAR FIRST SEMESTER - 2024

Subject : Electrical Generators and Transformers Part - II Full Marks : 30

Use Separate Answer scripts for each Part

Q1. Answer any two questions: CO1 2×3

(a) The cylindrical rotor alternators have small diameters and large length of core? Explain.
(b) Why should the speed of the synchronous generator be kept constant at synchronous speed?
(c) The voltage regulation for the lagging and the unity power factor operation of the synchronous generator is positive but may be negative for the leading power factor load. Justify the statement.
(d) Why is the short circuit characteristic of an alternator straight line?

Q2. Define any two terms: CO2 2×2

Breadth factor, Synchronizing Power, d-axis and q-axis Synchronous Reactance, Voltage Regulation

Q3. Answer any one question: CO3 1×3

(a) What is the role of damper winding in reducing the electro-mechanical transients in synchronous generator?
(b) Write down the conditions of synchronising an incoming alternator with the busbar?
(c) How does a Synchroscope work?

Q4. Answer any one question: CO5 1×3

(a) Develop the voltage phasor equation of a salient pole alternator working at lagging pf load.
(b) How does the power developed in a cylindrical rotor alternator vary with the load angle? Derive the expression.

Q5. Answer two questions: CO6 7×2

(a) Draw the open circuit and short circuit characteristics of 6.6 kV, 3 phase, 50 Hz star connected alternator having the following data:

Field current(A)	3.2	5.0	7.5	10.0	14.0
Terminal voltage on open circuit(kV)	3.1	4.9	6.6	7.5	8.24
Short Circuit Armature current (A)	500	778	1170		

Per phase armature resistance is 0.2 ohm. Find the voltage regulation on full-load current of 500 A at 0.8pf lagging using synchronous impedance method.

(b) A 3 phase star connected alternator with synchronous impedance of $0 + j5\ \Omega$ per phase is connected to an 11 kV system. The alternator power output is found to be 100 MW and the reactive power output is 3 MVA. Calculate the excitation voltage, load angle, line current and power factor.

(c) A 5 MVA, 1000V, 1500 rpm, 3-phase, 50 Hz, alternator is operating on infinite bus bar. Find synchronizing power per mechanical degree of angular displacement at full-load operating at rated voltage and 0.7 power factor lagging. Also find synchronizing torque for a 0.4 ° mechanical displacement in each case, Xs = 25%

(d) A salient pole synchronous generator has the following data:

$$x_d = 0.8 \text{ pu}, x_q = 0.5 \text{ pu}$$

If the generator is delivering rated kVA at rated voltage and at 0.8 pf lagging, calculate the power angle and the excitation emf. Also draw the phasor diagram. Neglect the armature resistance.

(e) A three phase, 8 pole, 50 Hz star connected synchronous generator has 120 stator slots. Each slot has 10 conductors and the coil span is 12 slots. Calculate the distribution factor and the pitch factor. If the flux/pole is 0.15 wb, find the line value of the induced emf.