B.E. Power Engineering 2nd Year 1st Semester Supplementary Examination, 2023
Sub: Electrical Generators and Transformers

Time 3 Hours **Full Marks 100**

(Use separate answer script for each Part)

Part I

(70 Marks)

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

Q1.a) Why is the condition of correct polarity most important and essential condition for parallel operation of transformer?

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

c) What is CRGOS?

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

e) What do you mean by in rush current for 3 phase transformers?

f) What is Hysteresis Loss?

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

Q2. i) All Day efficiency; (ii) Leakage Reactance; (iii) Magnetic Neutral Axis (iv) Commutation; (v) Voltage Regulation; (vi) Utilization Factor of 3 phase Transformers

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

Q3. a) Why distribution transformer should have low copper loss?

b) Draw phasor diagrams and circuit diagrams for the following transformer connections: Yz6, Dy11, Yd0

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

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

e) What is Sludging?

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

Q4. a) Show that, from an exact equivalent circuit, transformer is an inductance.

b) How tertiary winding is represented in equivalent circuit.

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

d) Draw the circuit diagram of a polarity Test in case of a Transformer

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

Q5. a) Show that for a Scott Connection, the neutral divides the teaser primary in 2:1 ratio.

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 zero voltage regulation for a single phase transformer.

d) Two transformers on open delta can be used to supply three phase power. Show it by derivation

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

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

Q6. a) A delta star, 6.6/0.44 kV bank of three identical single phase transformers supplies a three phase balanced load of 500kVA at 0.85pf 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.

Q6. b) 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 90% and operates at 0.85p.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. c) The maximum efficiency of a 40KVA, 50Hz, 1100/415V single-phase transformer is 97% and occurs at 80% of full load at unity power factor. If the impedance is 5%, calculate regulation at full-load 0.90 power factor lagging.

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 600 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) Find the flux per pole of a 50kW d.c generator having 4 poles, and a lap wound armature with 320 conductors. The machine is run at a speed of 750rpm and generates 480V. Resistance of the armature and shunt fields are 0.75 ohm and 250 ohms respectively. Find the current flowing through the armature at full load and the terminal voltage.

Q6.(h) 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 (i) 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.

Ref. No. : Ex/PE/PC/B/T/216/2023(S)

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

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

Use Separate Answer scripts for each Part

Q1. Answer any two questions: CO1 2×3

(a) Why is the salient pole construction used for low speed machines and cylindrical rotor construction used for high speed machines? Explain.

(b) Why should the speed of the synchronous generator be kept constant at synchronous speed?

(c) Show that the armature reaction effect in an alternator, while supplying the leading pf load has a magnetising effect.

(d) How does the change in excitation affect the operation of alternator on infinite busbar?

Q2. Define any two terms: CO2 2×2

Pitch Factor, Synchronizing Power, Hunting, d-axis and q-axis Synchronous Reactance

Q3. Answer any one question: CO3 1×3

(a) Derive the phasor diagram of a cylindrical rotor alternator at lagging pf load.

(b) What are the conditions of synchronising an incoming alternator with the busbar? How does a Synchroscope work?

Q4. Answer any one question: CO5 1×3

(a) Derive the expression for synchronizing torque of a cylindrical rotor alternator.

(b) How does the power developed in a salient pole alternator vary with the load angle? Derive the expression.

Answer two questions: CO6 7×2

(a) Draw the open circuit characteristic and short circuit characteristics of 150 MW, 13 kV, 0.8 pf, 3 phase, 50 Hz star connected alternator. A field current of 600 A is needed to circulate the short circuit current of 7500 A. The open circuit characteristic is given below:

Field current(A)	200	450	600	850	1200
Terminal voltage on open circuit(kV)	4	8.7	10.8	13.3	15.4

Find voltage regulation on full-load at 0.8pf lagging using synchronous impedance method at the terminal voltage of 13 kV.

(b) A 4 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 0.8 power factor lagging. Also find synchronizing torque for a 0.5 ° mechanical displacement in each case, Xs = 20%

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

$$x_d = 1.2 \text{ pu}, x_q = 0.5 \text{ pu}, r_a = 0.025 \text{ pu}$$

If the generator is delivering rated kVA at rated voltage and at 0.8 pf leading, compute the power angle and the excitation emf. Also draw the phasor diagram.

(d) 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.