Ref: PE/PC/T/(S)/216

B.E. Power Engineering 2nd Year 1st Semester Supplementary Semester Examination 2024

Sub: Electrical Generators and Transformers

Time : 3 Hours **Full Marks: 100**

Use separate answer script for each Part.

Part I (Marks: 70)

Answer **any four** of the following (CO1): **(4×2=8)**

Q1.a) What is Armature reaction?

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

c) How a 3 phase shell type transformer is obtained from 3 single phase shell type cores?

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

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

f) Why is short circuit test performed in transformers?

g) Why is the condition of correct polarity the most important and essential condition forparallel operation of transformer?

Define**any four**terms of the following (CO2): **(4×2=8)**

Q2. i) Magnetic neutral axis for dc generator; (ii) Leakage reactance; (iii); All Day efficiency (iv) Commutation; (v) Voltage regulation; (vi) Critical Speed

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, Dy0, Yd11

c) How armature reaction is controlled beneath the polar region in dc generator?

d). Why does the secondary terminal voltagechange for a Transformer as it is loaded?.

e) Why filtration of transformer oil is necessary in regular intervals?

Answer **any two** of the following (CO4): **(2×4=8)**

Q4. a) Show how iron loss is represented in an exact equivalent circuit of a transformer.

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) Explain with diagram the terminal voltage characteristics against load currentfor a separately excited DC generator.

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 for maximum voltage regulation for a single phase transformer.

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

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

Answer **any four** of the following (CO6): **(4×7=28)**

Q6. a)The O.C and S.C test data are given below for a single phase, 6 kVA, 200V/400V, 50Hz transformer.

O.C test from LV side : 200V 1.5A 250W

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.

[Turn over

Q6. b)The short-circuit tests on two single phase transformers gave the following results:
200 kVA: 3% rated voltage; rated current at 0.35 p.f. lag.
500 kVA: 4% rated voltage; rated current at 0.35p.f. lag.
These two transformers are connected in parallel. How do they share a load of 560 KW at 0.8 p.f. lag?

Q6. c) The maximum efficiency of a 30KVA, 50Hz, 1100/415V single-phase transformer is 98% and occurs at 80% of full load at unity power factor. If the impedance is 7%, calculate regulation at full-load 0.85 power factor lagging.

Q6.d) 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.

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?
iii) What is the real power supplied by each transformer?
iv) What would be the available capacity, if a third transformer of same rating is used to form the closed delta?

Q6.e) A single phase two winding 125 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 3.5% loss, 3.5% voltage regulation and 2.5% impendence. Determine the following for the auto-transformer:
(i) voltage and current rating (ii) kVA rating (iii) efficiency

Q6.f) A delta star, 6.6/0.4kV bank of three identical single phase transformers supplies a three phase balanced load of 800kVA 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.g) Find the flux per pole of a 60kW DC generator having 4 poles, and a lap wound armature with 320 conductors. The machine is running at a speed of 850rpm and generates 480V. Resistance of the armature and shunt fields are 0.85 ohm and 350 ohms respectively. Find the current flowing through the armature at full load and the terminal voltage.

Q6.h) A 6 pole DC shunt generator with a lap wound armature has an armature resistance of 0.25 ohm and a field resistance of 100ohms. The generator supplies sixty 100V, 40W lamps. Find the current in each armature conductor and the generator emf. The brush contact drop is 1.5V per brush.

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

B.E. POWER ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 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) Why the turbo-alternators are of non-salient pole types?

(b) What are the advantages of short pitched windings used in an alternator?

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

(d) What is the role of damper windings in an alternator?

Q2. Define any two terms: CO2 2×2

Distribution Factor, Synchronizing Torque, Synchronous Reactance, Coil span

Q3. Answer any one question: CO3 1×3

(a) Draw the phasor diagram of a salient pole alternator working at the leading pf load and derive the expression of $tan\Psi$ where Ψ is the angle between the current and the excitation emf.

(b) Describe the working of a Synchroscope?

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.

Q5. Answer two questions: CO6 7×2

(a) The open circuit characteristic of a 1MVA, 11kV, 50 Hz star connected alternator is as given below:

Field current(A)	50	110	140	180
Terminal voltage on open circuit(V)(line value)	7000	12500	13750	15000

A field current of 40 A is needed to circulate the full load rated armature current under short-circuit condition. The armature resistance is negligible. Calculate the voltage regulation at full-load 0.8 lagging power factor.

(b) An alternator has the following data:

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

The generator is delivering rated kVA at rated voltage and at 0.8 pf lagging. Compute the power angle and the open circuit emf. Also draw the phasor diagram. Neglect the armature resistance and saturation.

(c) A 2 MVA, 8 pole, 3-phase alternator is connected with 6000 V, 50 Hz bus bar. The synchronous reactance of the alternator is 4Ω/phase. Find synchronizing power and synchronizing torque per mechanical degree of angular displacement at full-load operating at rated voltage and 0.8 power factor lagging. Assume normal excitation.

(d) The resultant air gap flux of a 16 pole, 3 phase alternator is 0.16wb/pole and is distributed sinusoidally over the pole. The stator has 2 slots/pole/phase and 4 conductors per slot in two layers. The coil span is 150 electrical degree. Calculate the distribution factor, the pitch factor and the excitation emf when the alternator runs at 375 rpm.