UNIT – II - TRANSFORMERS

PART – A

1. Define a transformer?

A transformer is a static device which changes the alternating voltage from one level to another.

2. What is the turns ratio and transformer ratio of transformer? Turns ratio = N2/ N1
Transformer = E2/E1 = I1/ I2 =K

3. Mention the difference between core and shell type transformers?

In core type, the windings surround the core considerably and in shell type the core surrounds the windings i.e winding is placed inside the core.

4. What is the purpose of laminating the core in a transformer?
In order to minimise eddy current loss.

5. Give the emf equation of a transformer and define each term?

Emf induced in primary coil E1= 4.44fΦmN1 volt emf induced in secondary Coil E2 =4.44 fΦmN2.
f--------freq of AC input
Φ----------maximum value of flux in the core
N1, N2---------Number of primary & secondary turns.

6. Does transformer draw any current when secondary is open? Why?

Yes, it(primary) will draw the current from the main supply in order to magnetize the core and to supply for iron and copper losses on no load. There will not be any current in the secondary since secondary is open.

7. Define voltage regulation of a transformer?

The change in secondary terminal voltage from no load to full load expressed as a percentage of no load or full load voltage is termed as regulation. %regulation down=(V2noload- V2full load)*100/ V2noload,
%regulation up=(V2noload-V2F.L)*100/V2F.L

8. Define all day efficiency of a transformer?

It is computed on the basis of energy consumed during a certain period, usually a day of 24 hrs. all day efficiency=output in kWh/input in kWh for 24 hrs.

9. Why transformers are rated in kVA?

Copper loss of a transformer depends on current & iron loss on voltage. Hence total losses depend on Volt-Ampere and not on PF. That is why the rating of transformers are in kVA and not in kW.

10. What determines the thickness of the lamination or stampings?
1. Frequency 2. Iron loss

11. What are the typical uses of auto transformer?
1. To give small boost to a distribution cable to correct for the voltage drop.
2. As induction motor starter.

12. What are the applications of step-up & step-down transformer?

Step-up transformers are used in generating stations. Normally the generated voltage will be either 11kV. This voltage (11kV) is stepped up to 110kV or 220kV or 400kV and transmitted through transmission lines (simply called as sending end voltage).

Step-down transformers are used in receiving stations. The voltage are stepped down to 11kV or 22kV are

stepped down to 3phase 400V by means of a distribution transformer and made available at consumer premises. The transformers used at generating stations are called power transformers.

13. How transformers are classified according to their construction?

1. Core type 2.shell type. In core type, the winding (primary and secondary) surround the core and in shell type, the core surround the winding.

14. Explain on the material used for core construction?

The core is constructed by sheet steel laminations assembled to provide a continuous magnetic path with minimum of air gap included. The steel used is of high silicon content sometimes heat treated to produce a high permeability and a low hysteresis loss at the usual operating flux densities. The eddy current loss is minimized by laminating the core, the laminations being used from each other by light coat of core-plate vanish or by oxide layer on the surface. The thickness of lamination varies from 0.35mm for a frequency of 50Hz and 0.5mm for a frequency of 25Hz.

15. How does change in frequency affect the operation of a given transformer?

With a change in frequency, iron and copper loss, regulation, efficiency & heating varies so the operation of transformer is highly affected.

16. What is the angle by which no-load current will lag the ideal applied voltage?

In an ideal transformer, there are no copper & core loss i.e. loss free core. The no load current is only magnetizing current therefore the no load current lags behind by angle 900. However the winding possess resistance and leakage reactance and therefore the no load current lags the applied voltage slightly less than 900.

17. List the arrangement of stepped core arrangement in a transformer?

1. To reduce the space effectively
2. To obtain reduce length of mean turn of the winding
3. To reduce I2R loss.

18. Why are breathers used in transformers?

Breathers are used to entrap the atmospheric moisture and thereby not allowing it to pass on to the transformer oil. Also to permit the oil inside the tank to expand and contract as its temperature increases and decreases.

19. What is the function of transformer oil in a transformer?

1. It provides good insulation
2. Cooling.

20. Can the voltage regulation go –ive? If so under what condition?

Yes, if the load has leading PF.

21. Distinguish power transformers & distribution transformers?

Power transformers have very high rating in the order of MVA. They are used in generating and receiving stations. Sophisticated controls are required. Voltage ranges will be very high. Distribution transformers are used in receiving side. Voltage levels will be medium. Power ranging will be small in order of kVA. Complicated controls are not needed.

22. Name the factors on which hysteresis loss depends?

1. Frequency 2. Volume of the core 3. Maximum flux densitY

23. Why the open circuit test on a transformer is conducted at rated voltage?

The open circuit on a transformer is conducted at a rated voltage because core loss depends upon the voltage. This open circuit test gives only core loss or iron loss of the transformer.

24. What is the purpose of providing Taps in transformer and where these are provided?

In order to attain the required voltage, taps are provided, normally at high voltages side(low current).

25. What are the necessary tests to determine the equivalent circuit of the transformer?

1. Open circuit test
2. Short circuit test

26. Define regulation and efficiency of the transformer?

The regulation of the transformer is defined as the reduction in magnitude of the terminal voltage due to load, with respect to the no-load terminal voltage.

% regulation = (V2 on no-load- V2 when loaded/ V2 on no-load)x 100 Transformer efficiency n= (output power/input power)x 100

Unit II

① Draw the circuit diagram for single phase Transformer and also explain the principle Construction working of it.

Construction details:

(i) Magnetic Core.
(ii) Primary and secondary winding.
(iii) Insulation of winding.
(iv) Expansion tank (or) Conservator.
(v) Lead and tappings for coils with their supports, terminals and terminals. insulators
(vi) Tank, oil, Cooling arrangement, temperature gauge, oil gauge.
(vii) Buchholz Relay
(viii) Silica gel breather

② Obtain the Mathematical EMF equation of a Transformer and explain each term.

$$\text{Form factor} = \frac{\text{R.M.S Value}}{\text{Average Value}}$$

RMS value of emf induced / turn $= 4f \times \phi_m$ Volt.

$= 1.11 \times (4f\,\phi_m)$

$= 4.44 f \phi_m$ Volts.

$E_1 = 4.44 f \phi_m \times N_1$

$E_1 = 4.44 f B_m A N_1$ Volts.

$E_2 = 4.44 f B_m A N_2$ Volts.

T/F Ratio $= \frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = K.$

(13) Draw the circuit diagram of TF and also obtain the equivalent circuit and Mathematical expression for a Transformer.

* Equivalent CKT Diagram
* Equivalent circuit of a Transformer referred to primary.
* Equivalent circuit of a Transformer referred to secondary.

Referred to primary:

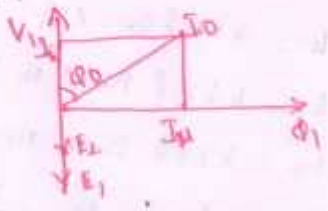
$$R_2' = R_2 / K^2$$
$$X_2' = X_2 / K^2$$
$$I_2' = I_2$$
$$Z_2' = Z_2 / K^2$$

Referred to secondary:

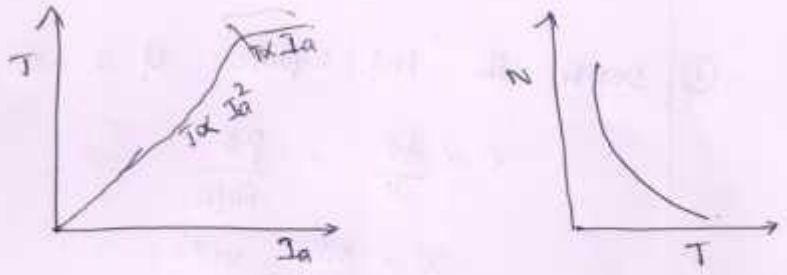
$$R_{02} = R_2 + R_1' = R_2 + K^2 R_1$$
$$X_{02} = X_2 + X_1' = X_2 + K^2 X_1$$
$$Z_{02} = \sqrt{R_{02}^2 + X_{02}^2}$$

(14) Explain the phasor diagram no load condition on load condition.

No loaded conditions:



Torque armature Current characteristics:



(5) Explain the different techniques for the speed Control of DC Series Motor.

* Variable resistance in series with Motor.
* Flux Control Method.
* Armature divertor.
* Tapped field Control.
* paralleling field Coil.

Explanation:

(6) A 230V DC Shunt Motor takes an armature current of 2.3A at rated voltage and at a no load speed 1000rpm. The resistances of the armature Circuit and field Circuit are respectively 0.3Ω and 160Ω. The line current at full load and rated voltage is 40A. Calculate the full load speed and the developed torque If the armature reaction

G.D:

$V = 230V$, $I_a = 2.3A$, $R_a = 0.3\Omega$, $I_L = 40A$, $R_{sh} = 160\Omega$

$\Phi_2 = 0.96\Phi_1$

$N_2 = 993.57$ rpm.

$T_a = 81$ N-m.

$\frac{E_{b1}}{E_{b2}} = \frac{N_1}{N_2} \times \frac{\Phi_1}{\Phi_2}$

II Unit

(7) Derive the Emf equation of a DC Generator. (8 Marks)

$$e \propto \frac{d\phi}{dt} = \frac{P\phi}{60/N}.$$

$$e = \frac{NP\phi}{60} \text{ volts}.$$

$$E_g = \frac{\phi Z NP}{60A}$$

(8) Describe Swinburne's test with the help of a neat diagram to find out the efficiency of a DC Machine.

Circuit diagram:

* Indirect Method of testing dc motors.
* Power input at no load = $V(I_a + I_{sh})$

Copper loss = VI_{sh}.

Armature Copper loss = $I_a^2 R_a$.

Stray loss = $V(I_a + I_{sh}) - (VI_{sh}) - (I_a^2 R_a) = W_a$

$= I_{sh}^2 R_{sh}$.

$$\eta = \frac{\left(V \times \frac{I_{FL}}{4}\right) - I_a'^2 R_a - W_f - W}{V \times \frac{I_{FL}}{4}}$$

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