3474

BOARD DIPLOMA EXAMINATION, C-09

OCT/NOV - 2013

DEEE - FOURTH SEMESTER EXAMINATION

AC MACHINES - I

KEY

1. A transformer consists of primary, secondary windings surrounded to a core. And a transformer can be equivalently represented as an equivalent circuit consisting of Resistances and reactances.

By conducting open circuit test or No load test Iron losses can be found, from that equivalent no load resistance R_0 and No load reactance X_0 can be calculated.

By conducting SC Test or Full load test the full load copper losses of the transformer can be found, from that total resistance (R_{01}), total reactance (X_{01}) and total impedance (Z_{01}) referred to primary can be calculated.

R_0, X_0, R_{01}, X_{01} are the equivalent circuit parameters of the transformer.

COCI—EE _ 402

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@555 _FOURTH SEMESTER EXAMINATION

AC MACHINES —1

KEY

2. classification of transformers

1. According to no. of phases
   a. Single phase transformer
   b. Three phase transformer.

2. According to Construction
   a. Core type transformer
   b. Shell type transformer
   c. Berry type transformer.

3. Various losses of a transformer

1. Core or Iron losses
   - (a) Hysteresis loss
   - (b) Eddy Current loss

2. Copper losses
   - (a) Primary winding cu loss
   - (b) Secondary winding cu loss

and we know that

$$\text{Copper loss} = I^2R$$

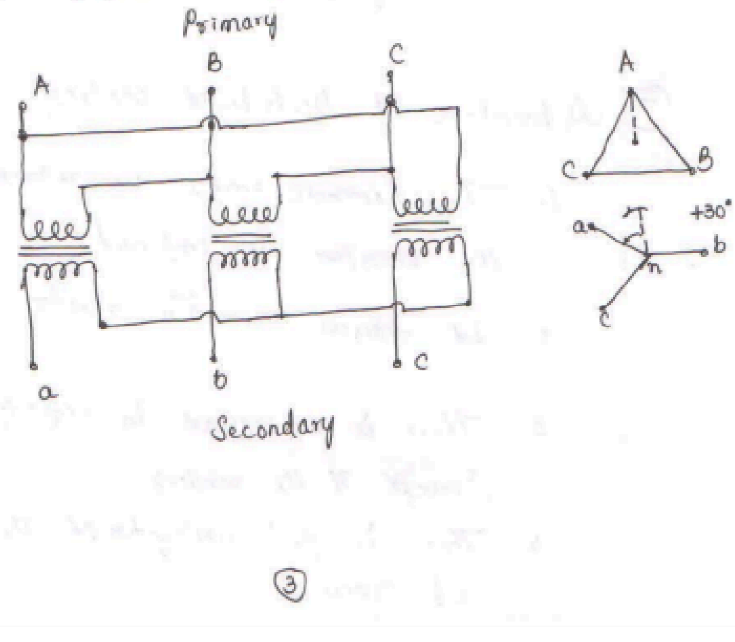
$$\text{i.e. Copper loss} \propto I^2$$

If the load current increases by 2 times, cu loss increases by 4 times.

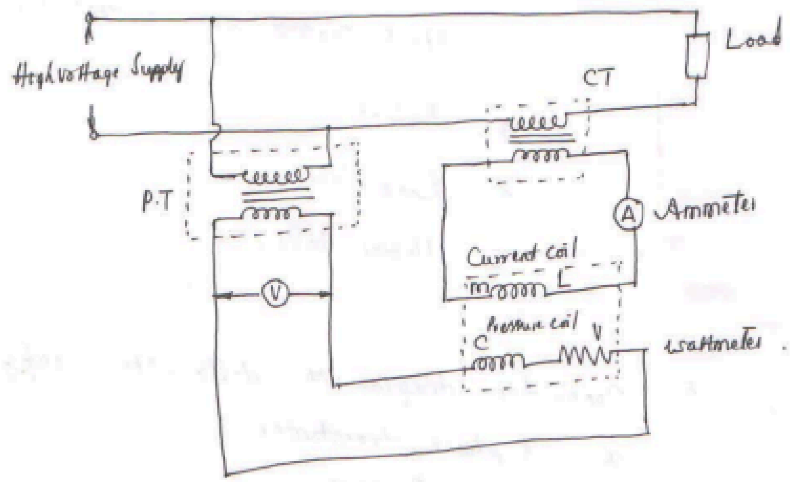
4. Advantages of Welding transformer Any $3 \times 1 = 3m$.

1. Smooth Control of welding Current
2. High OC voltage for +ve arc striking
3. Protection against under voltage, over voltage, short circuit and against over temperature
4. Releable
5. Long life
6. Heavy duty.

5. Connection diagram of delta - star configuration of a 3 phase transformer



(6) Circuit diagram for measurement of power in 1-phase circuit with the help of Instrument transformers :

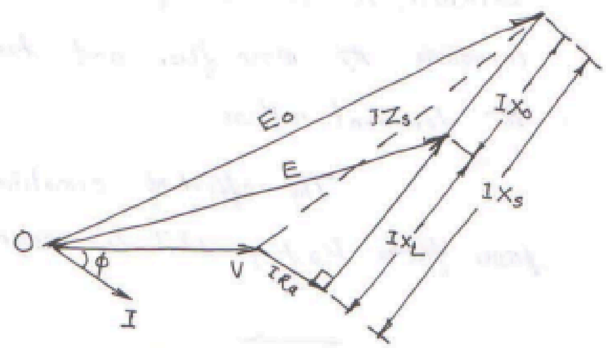


(7) Advantages of Distributed windings

1. The harmonic emf's are reduced and so the waveform is improved
2. It reduces armature reaction and armature reactance.
3. There is an increase in rigidity and mechanical Strength of the winding.
4. There is full utilization of the armature iron and copper.

a. qww MIME-e

8. Phasor diagram of an alternator for lagging power factor load:



E_0 = No load emf = $V + I Z_s$

E = emf induced on load

V = Terminal Voltage

ϕ = Load p.f. angle.

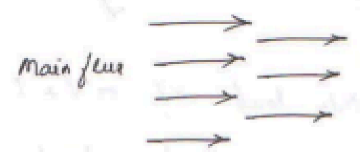
9. The effect of Armature reaction of Alternator for Zero power factor leading load:

when the purely capacitive load is connected across the armature terminals of an Alternator, the armature Current will lead

the induced emf by 90°

In this case the armature flux is the same direction as that of the main flux. Both the fluxes ϕ_a and ϕ_f are helping eachother, therefore the effect is magnetising. This increases the main flux and hence increases in the terminal voltage.

The effect of armature reaction for power factor leading will be magnetising.



(10) Conditions for Synchronization of an Alternator:

1. The terminal voltage of the incoming machine must be same.
2. The frequency of the incoming machine must be equal to the bus bar frequency.
3. The phase of the incoming machine voltage must be same.
4. For 3ϕ Alternator, the phase sequence of the incoming machine is the same.

Part – B

(7)

(11) Two Single phase transformers running in parallel.

Total load in kW = 100 kW

Load power factor $\cos\phi$ = 0.8 lag.

Load angle $\phi = \cos^{-1}(0.8) = 36.86^\circ$

Impedance of transformer A referred to secondary $Z_A = (0.5 + j3)\ \Omega$

Impedance of transformer B referred to secondary $Z_B = (0.6 + j10)\ \Omega$

Load shared by transformer A, $S_A = ?$

" B, $S_B = ?$

$$\text{Total load KVA} = \frac{\text{Total load kW}}{\text{p.f}}$$

$$= \frac{100 \times 10^3}{0.8} = 125 \text{ KVA}$$

Hence total load $S = 125 \angle -36.87^\circ$

Impedance of transformer A, $Z_A = (0.5 + j3) = 3.04 \angle 80.5^\circ$

" B, $Z_B = (0.6 + j10) = 10.02 \angle 86.56^\circ$

CD

Impedanc

*f *0*

% Magma, A WWWO

and

$$Z_A + Z_B = (0.5 + j3) + (0.6 + j10)$$

$$= (1.1 + j13)$$

$$= 13.04 \angle 85.16^\circ$$

Load shared by transformer A,

$$S_A = S \times \frac{Z_B}{Z_A + Z_B}$$

$$= 125 \angle{-36.87^\circ} \times \frac{10.02 \angle 86.56^\circ}{13.04 \angle 85.16^\circ}$$

$$= 96.05 \angle{-35.47^\circ} \text{ KVA}$$ Ans.

Load shared by transformer B,

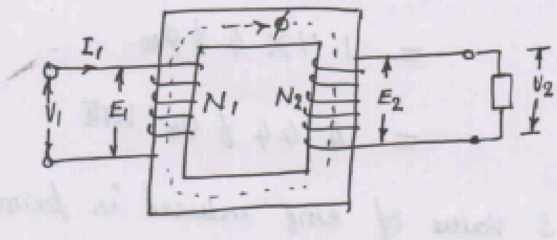
$$S_B = S \times \frac{Z_A}{Z_A + Z_B}$$

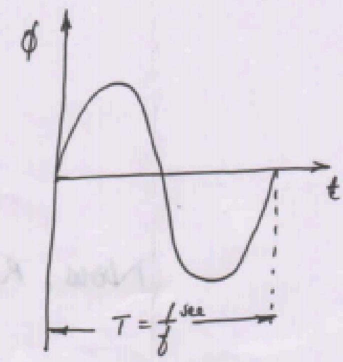
$$= 125 \angle{-36.87^\circ} \times \frac{3.04 \angle 80.5^\circ}{13.04 \angle 85.16^\circ}$$

$$= 29.14 \angle{-41.53^\circ} \text{ KVA}$$ Ans

26-56 15.04. 1.85/6.

12(a) Derivation of EMF equation of 1ϕ transformer:





Schematic diagram

When an a.c. voltage is applied to the primary winding an alternating flux is produced in the core whose waveform is shown.

The magnetic flux is increased from zero to maximum value ϕ_m in one-forth of cycle i.e. $\frac{1}{4f}$ second.

Avg rate of change of flux, $\frac{d\phi}{dt} = \frac{\phi_m}{\left(\frac{1}{4f}\right)} = 4f\phi_m$ volts

Now rate of change of flux is equal to the average emf induced per turn in volts.

Avg emf per turn $= 4 f \phi_m$

We know

$$\text{Form factor} = \frac{\text{R.M.S. value}}{\text{Avg value}} = 1.11$$

M W m 1 mm

∴ RMS value of emf / turn

$= 1.11 \times$ Average emf / turn

$= 1.11 \times 4 f \phi_m$

$= 4.44 f \phi_m$ volts

Now, RMS value of emf induced in primary winding

$E_1 =$ emf induced per turn × No. of primary turns.

$= 4.44 f \phi_m \times N_1$ volts

$= 4.44 f N_1 B_m A$ volts $\left(\because B_m = \frac{\phi_m}{A}\right)$

Similarly RMS value of emf induced in secondary winding can be proved.

$E_2 = 4.44 f N_2 B_m A$ volts

12 (b)

Primary induced emf $E_1 = 260V$

Secondary " $E_2 = 117V$

Max. flux density of core $\phi_m = 1.4$ Tesla

Emf per turn of 1φ transformer = 13 V

Calculate (i) $N_1 = ?$, $N_2 = ?$

(ii) Net cross sectional area of core $A = ?$