Title : Single Phase Transformers

Date: 23/03/2020
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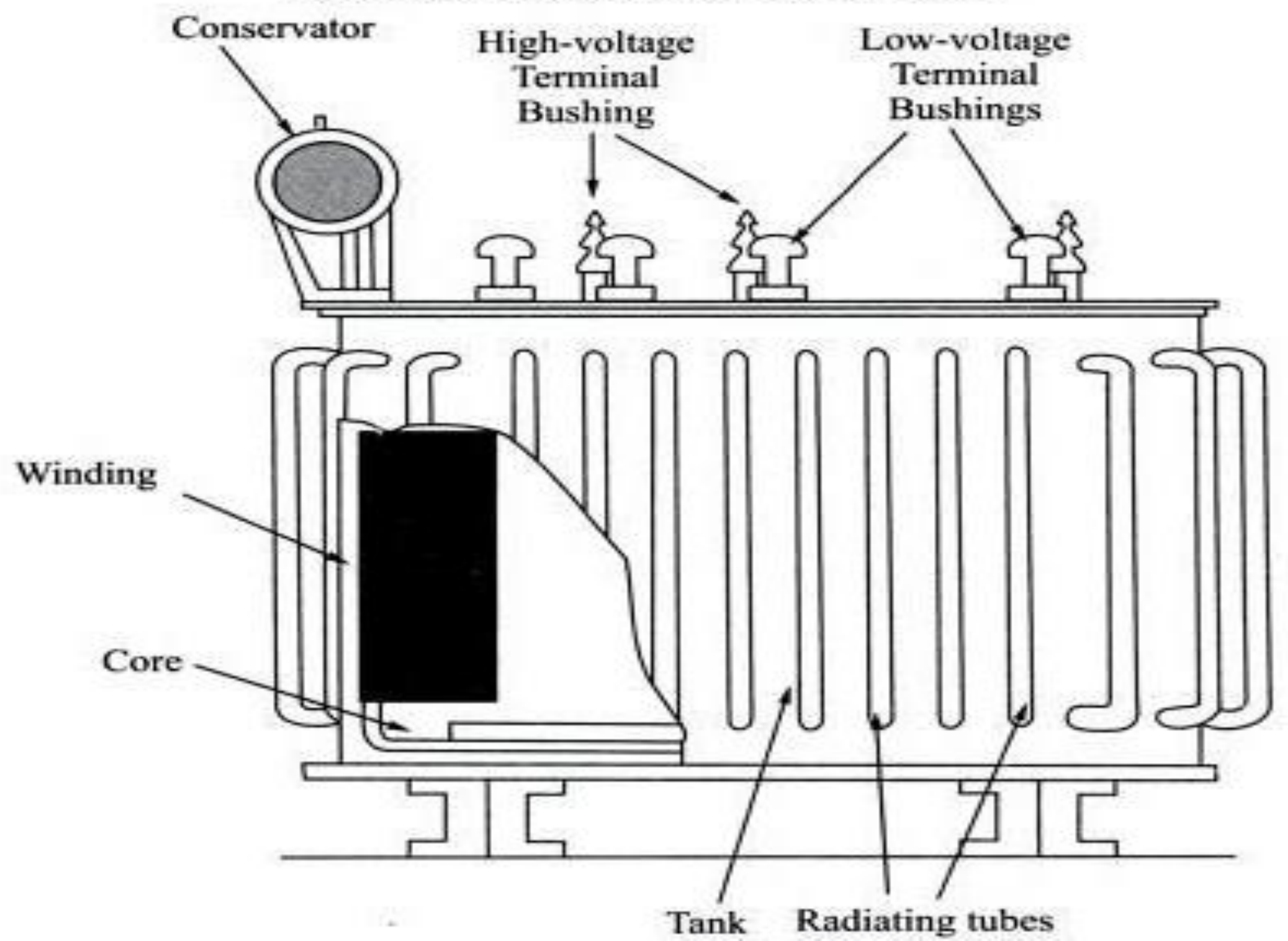
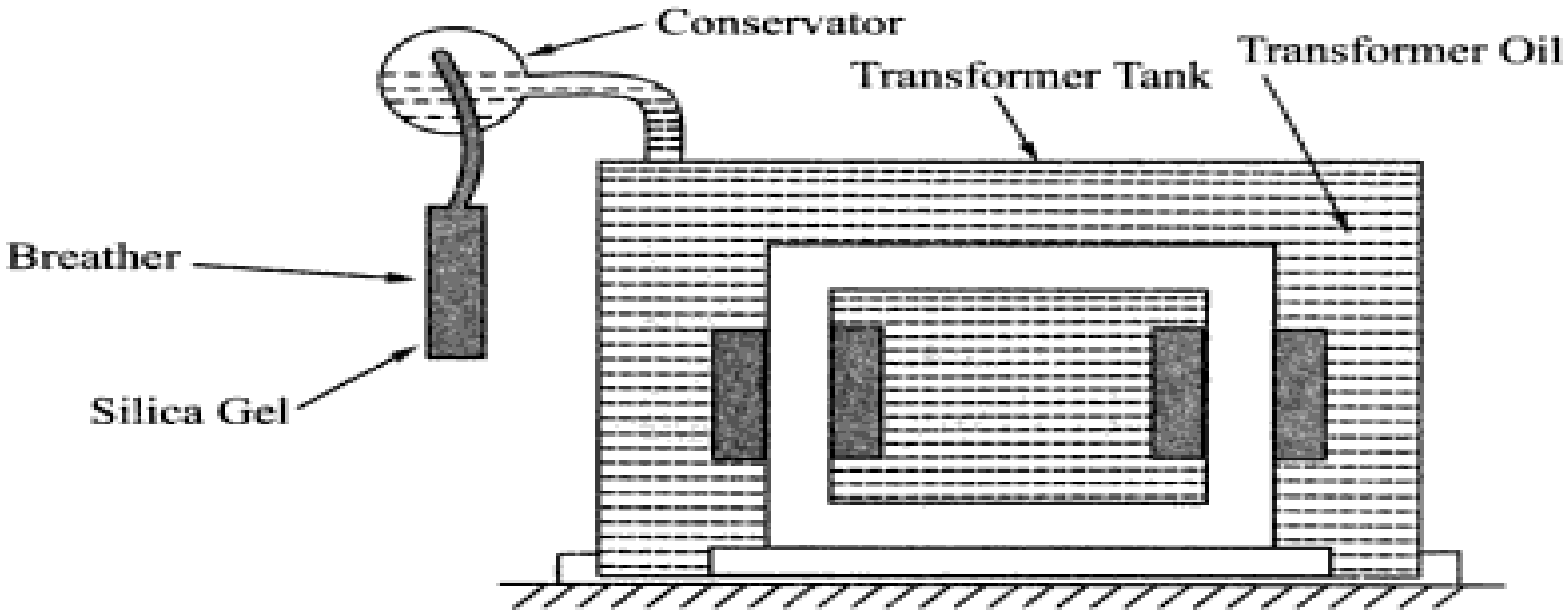
Lecture No : 06
Source of information : B. L. Theraja, “Electrical Technology – Part I and II”, S. Chand and Co. 2012
Page no.

Cut view of transformer



Transformer with conservator and breather



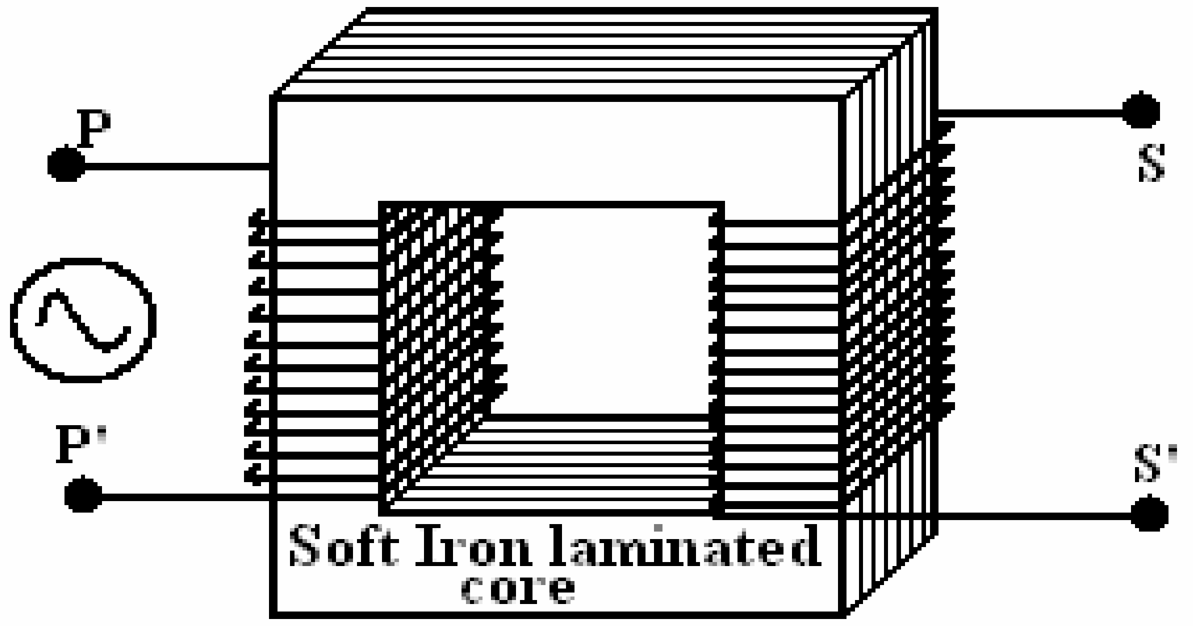
Working of a transformer

1. When current in the primary coil changes being alternating in nature, a changing magnetic field is produced

2. This changing magnetic field gets associated with the secondary through the soft iron core

3. Hence magnetic flux linked with the secondary coil changes.

4. Which induces e.m.f. in the secondary.



Single Phase Transformer

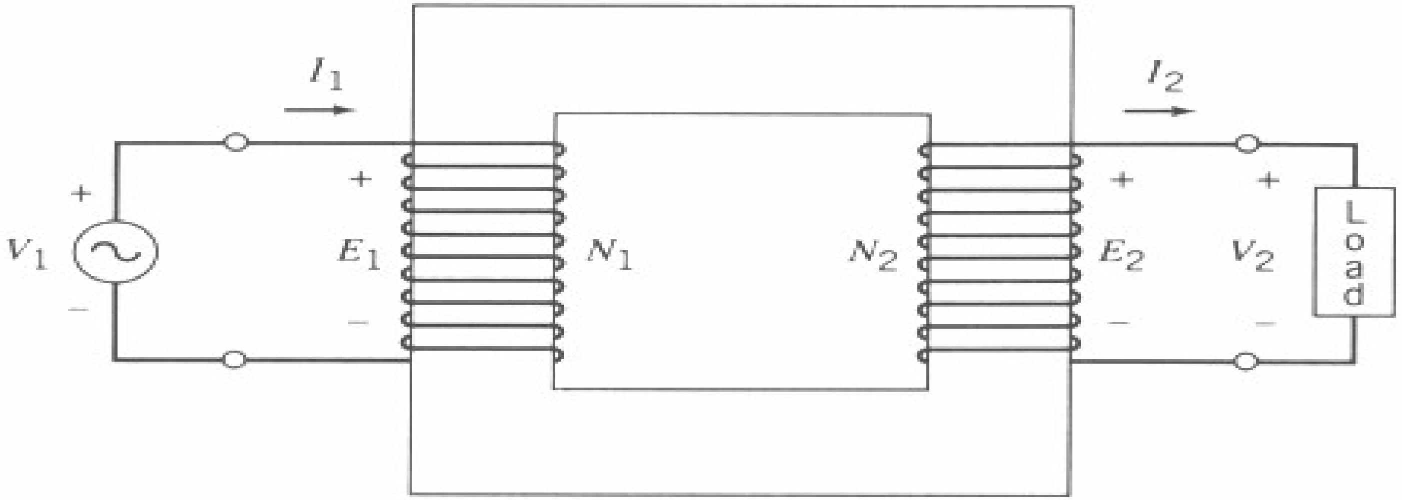


FIGURE 4.8 A transformer circuit.

- A single phase transformer
  - Two or more winding, coupled by a common magnetic core

Ideal Transformers

Zero leakage flux:

-Fluxes produced by the primary and secondary currents are confined within the core

The windings have no resistance:

- Induced voltages equal applied voltages

The core has infinite permeability

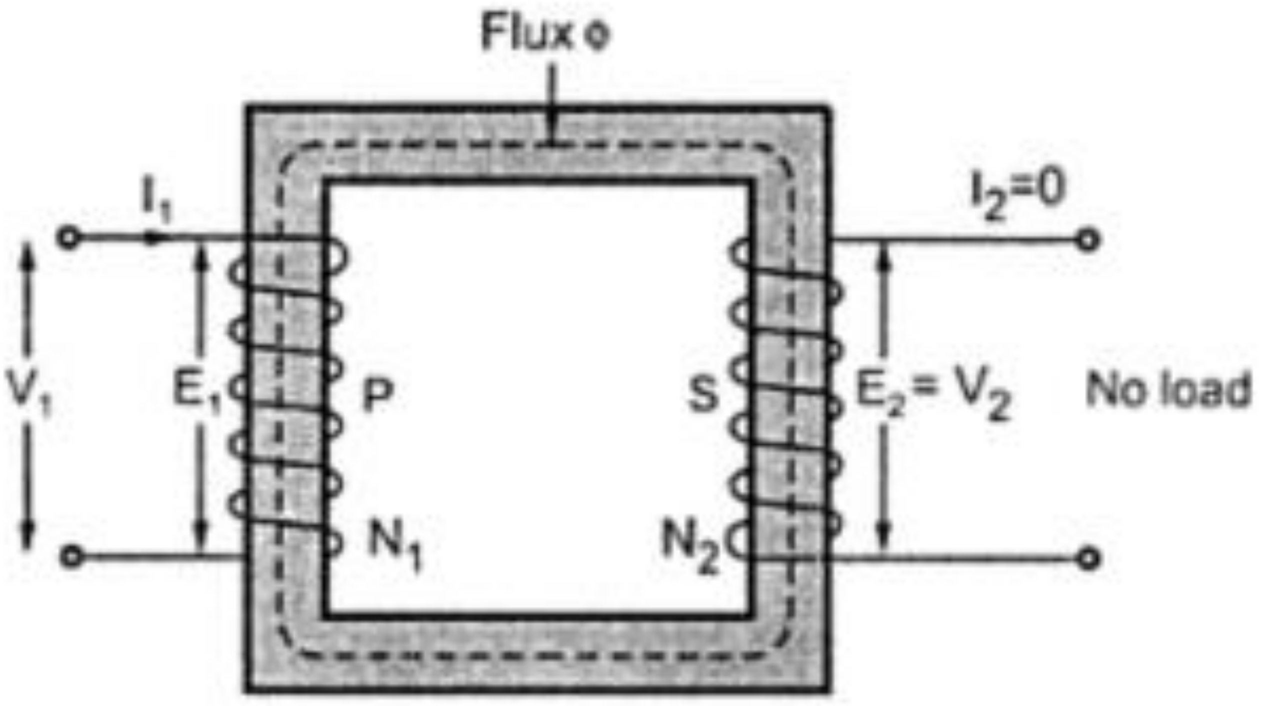
- Reluctance of the core is zero

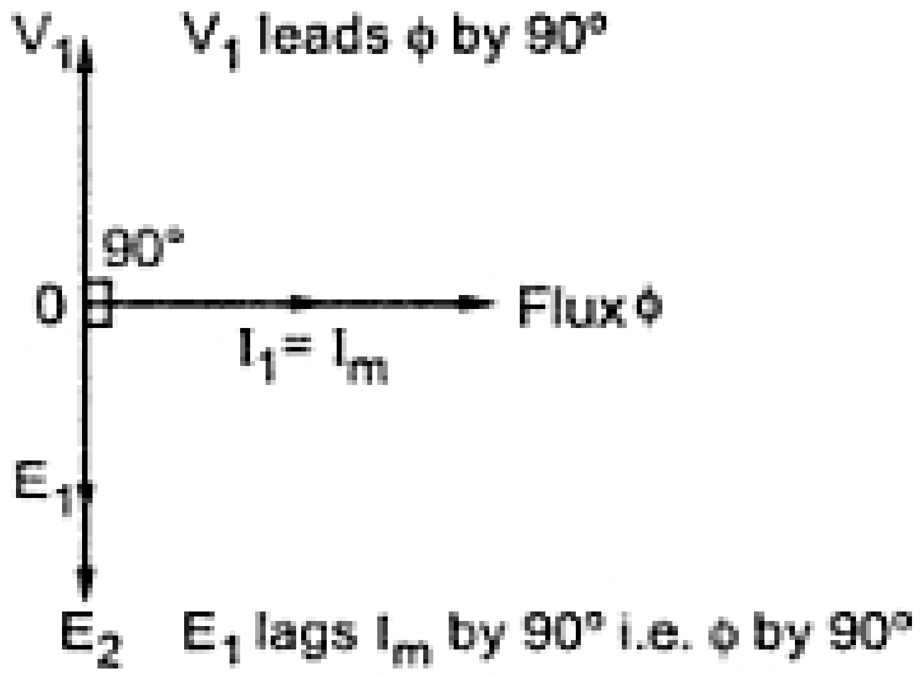
- Negligible current is required to establish magnetic flux

Loss-less magnetic core

- No hysteresis or eddy currents

Ideal transformer





V_1 – supply voltage ; I_1- noload input current ;
V_{2-} output voltgae; I_2- output current
I_m- magnetising current;
E_1-self induced emf ; E_2- mutually induced emf

EMF equation of a transformer

EMF equation of the Transformer

Let,
N_1 = Number of turns in primary winding
N_2 = Number of turns in secondary winding
Φ_m = Maximum flux in the core (in Wb) = (B_m x A)
f = frequency of the AC supply (in Hz)

EMF equation of a transformer

As, shown in the fig., the flux rises sinusoidally to its maximum value Φ_m from 0. It reaches to the maximum value in one quarter of the cycle i.e in T/4 sec (where, T is time period of the sin wave of the supply = 1/f).

Therefore,

average rate of change of flux = $\Phi_m / (T/4) = \Phi_m / (1/4f)$

Therefore,

average rate of change of flux = $4f\,\Phi_m$ .... (Wb/s).

Now,

Induced emf per turn = rate of change of flux per turn

Therefore, average emf per turn = $4f\,\Phi_m$ ....(Volts).

EMF equation of a transformer

Now, we know, Form factor = RMS value / average value
Therefore, RMS value of emf per turn = Form factor X average emf per turn.

As, the flux Φ varies sinusoidally, form factor of a sine wave is 1.11

Therefore, RMS value of emf per turn = 1.11 x 4f Φ_m = 4.44f Φ_m.

RMS value of induced emf in whole primary winding (E_1) = RMS value of emf per turn X Number of turns in primary winding

$E_1 = 4.44f\ N_1\ \Phi_m$ .... eq 1

EMF equation of a transformer

Similarly, RMS induced emf in secondary winding (E_2) can be given as

$E_2 = 4.44f\ N_2\ \Phi_m$. .... eq 2

from the above equations 1 and 2,

This is called the **emf equation of transformer**, which shows, emf / number of turns is same for both primary and secondary winding.

For an ideal transformer on no load, $E_1 = V_1$ and $E_2 = V_2$.
where, V_1 = supply voltage of primary winding
V_2 = terminal voltage of secondary winding

All day efficiency

$$\text{ordinary commercial efficiency} = \frac{\text{out put in watts}}{\text{input in watts}}$$

$$\eta_{all\ \text{day}} = \frac{\text{output in kWh}}{\text{Input in kWh}} (\ for\ 24\ \text{hours})$$

- All day efficiency is always less than the commercial efficiency

Assignment:

1) Define transformers and explain working and construction of single phase transformers?

2) What is Ideal Transformers?

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