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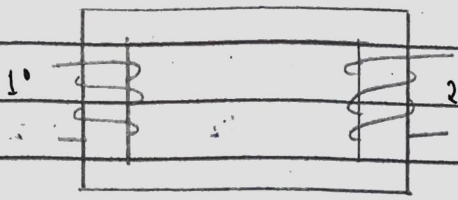
20th Dec

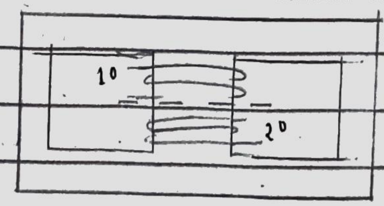
On basis of construction

(i) Core type transformer

1. 

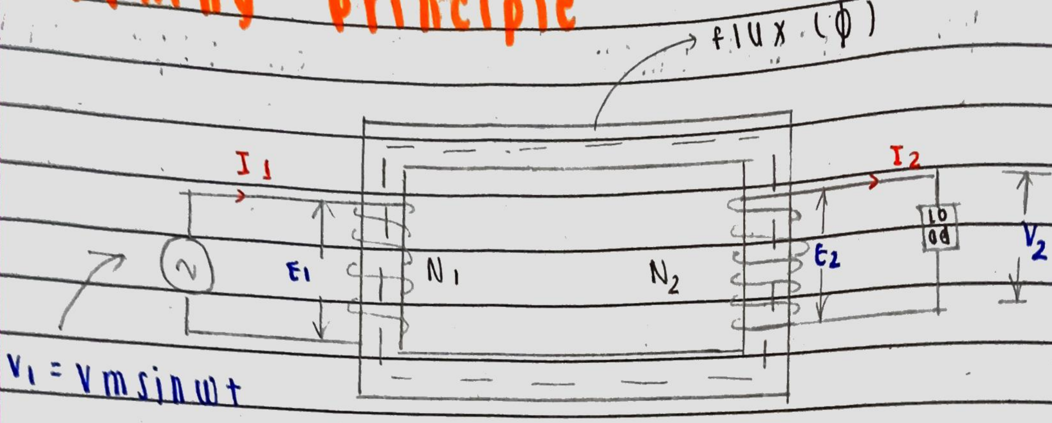
2. No. of legs / limbs is 2
3. No. of magnetic path => 1
4. 1° & 2° windings are placed on both limbs
5. Concentrated winding / cylindrical winding is used.
6. Natural cooling is effective.
7. Used in power transformer, (high voltage app)
8. Large amount of copper is reqd.

(ii) Shell type transformer

1. 

2. No. of legs / limbs is 3.
3. No. of magnetic path is 2.
4. 1° & 2° windings are placed on central limb
5. Sandwiched type winding is used.
6. Natural cooling is not effective.
7. Used in electronic gadgets (low voltage app).
8. Less amount of Cu is reqd.

working principle



Transformer works on the principle of Faraday's law of electromagnetic induction (mutual induction)

consider a simple transformer as shown in fig which consists of two windings which are

- electrically separated

but,

- magnetically linked through a path of low reluctance

when an AC supply is connected to 1° winding, it sets up an alternating flux in the core

which links w· secondary winding & hence an emf is induced in 2° winding [illegible] current that will

[illegible] transferred from

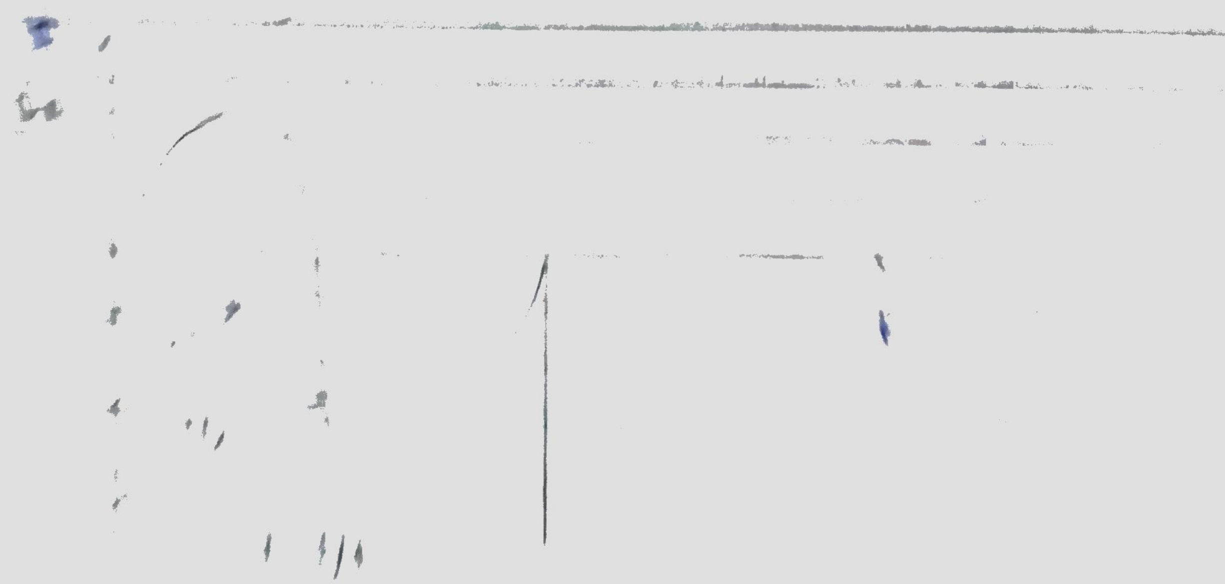
[illegible] ckt by electromagnetic induction w/o any change in freq

[illegible] links with 1° winding

[illegible] which opposes the applied [illegible]

[illegible] which limits 1° current (I_1)

[illegible] of transformer



let

N_1 = no. of turns in 1°

N_2 = no. of turns in 2°

A = Area of cross-section

ϕm = max flux

Bm = max flux density

f = freq

Note :

- capital letters $\xrightarrow{\text{denotes}}$ Rms value

when an alternating voltage is applied to the primary winding of the transformer, an alternating flux is set up in the core

which links w. both 1° & 2° winding.

$$dt = \text{final} - \text{initial}$$

$$= \frac{T}{4} - 0$$

$$= \frac{T}{4}$$

$$d\phi = \phi m - 0$$

$$= \phi m$$

$$\frac{d\phi}{dt} = \frac{\phi m}{T/4}$$

* Avg. $\frac{d\phi}{dt} = 4\phi m f$

we know that

$$e_{avg} = N\frac{d\phi}{dt}$$

$$\Rightarrow \frac{e_{avg}}{N} = \frac{d\phi}{dt} \rightarrow 4\phi m f$$

$$\Rightarrow \frac{e_{avg}}{N} = 4\phi m f$$

$$\therefore e_{avg} = 4\phi m f N \quad \text{(i)}$$

For pure sinusoidal quantity

Form factor = 1.11

$$\frac{\text{Rms value}}{\text{avg value}}$$

$\therefore$ RMS value = 1·11 * Avg. value

$\therefore$ RMS value of induced emf
= 1·11 * Avg. value of induced emf.

$\Rightarrow E_{rms} = 1{\cdot}11 * 4 f \phi_m N$

$E_{rms} = 4{\cdot}44 f B_m A N$

Now,

· 1° winding

$\boxed{E_1 = 4{\cdot}44 f B_m A N_1}$ → (ii)

· 2° winding

$\boxed{E_2 = 4{\cdot}44 f B_m A N_2}$ → (iii)

Voltage/ current Transformation Ratio / True Ratio / Turn Ratio (K)

Dividing eqⁿ (iii) by eqⁿ (i)

$$\frac{E_2}{E_1} = \frac{4{\cdot}44 f \cancel{B_m} A N_1}{4{\cdot}44 f \cancel{B_m} A N_2}$$

or, $\boxed{\frac{E_2}{E_1} = \frac{N_1}{N_2} = K}$

$V_2 = E_2$
$V_1 = E_1$

If winding losses are neglected

$\frac{V_2}{V_1} = \frac{E_2}{E_1} = \frac{N_2}{N_1} = K$

(i) If

- $V_2 > V_1$; $K > 1$

$N_2 > N_1$,

Thus step up transformer

(ii) If

- $V_1 > V_2$; $K < 1$

$N_2 < N_1$,

Thus step down transformer

(iii) If,

- $V_1 = V_2$; $K = 1$

$N_2 = N_1$

Thus, isolation transformer

• Current Transformer

Consider an ideal transformer

↓

losses negligible

I/p VA = O/p VA

↓

Apparent power

or, $V_1 I_1 = V_2 I_2$

$$\frac{V_2}{V_1} = \frac{I_1}{I_2} \longrightarrow (ii)$$

From eqⁿ (i) & (ii)

$$\frac{V_2}{V_1} = \frac{E_2}{E_1} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = K$$

• Note :

Ohm's law not applicable in transformer

↳ $V \propto I$ (x)

• **Note:** • Active power P → watt
• Reactive power Q → VAR [R→
• Apparent power S → VA (volt-Ampere)

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Ideal Transformer

For better understanding & easier explanation of a practical transformer. certain **assumptions** are made.

Practically ∴ an ideal transformer can't exist; its hypothetical only.

• **Assumptions made:**

(i) No winding resistance → 1° (I^2R loss X)

(ii) No magnetic leakage → flux boundary obitrai

(iii) No $\underbrace{\text{hysteresis \& Eddy}}_{\text{iron}}$ current loss

(iv) 0 magnetizing current → ↑ μ (permeable) ∴ no reluctance.

From above points we can conclude that an ideal transformer is supposed to consists of 2 purely inductive coils

↓ wound on

lossless core

Transformer on no load