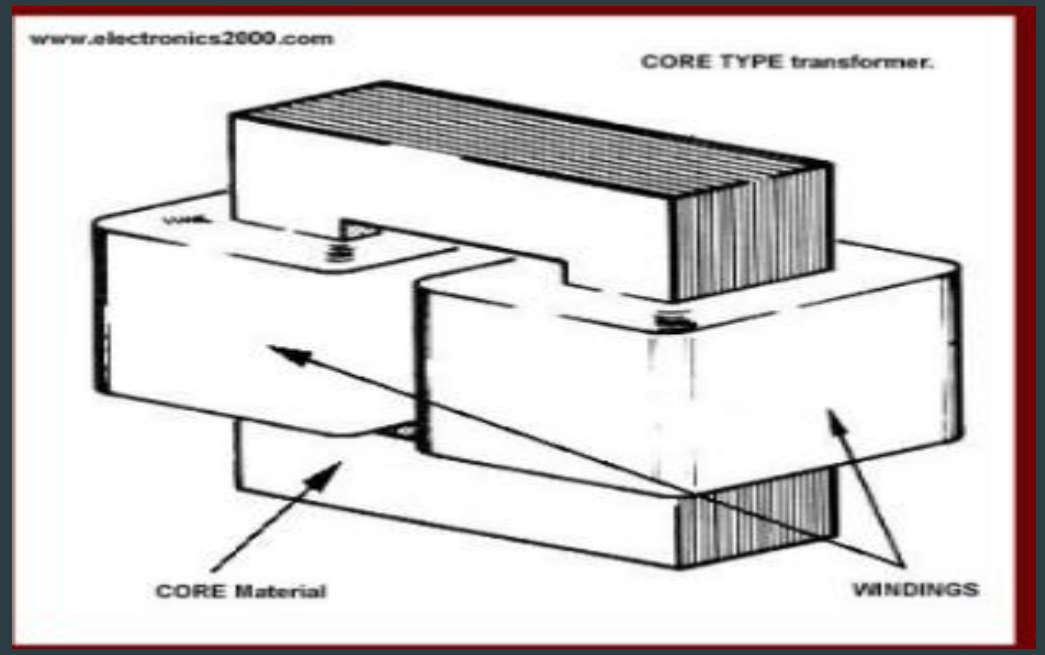
Introduction to Transformer

Introduction

- Transformer is a static device.
- It transfer electrical energy from one part of the electrical or electronic circuit to other part of circuit without changing the frequency.
- It works on the Michal Faradays law of Electromagnetic Mutual Induction

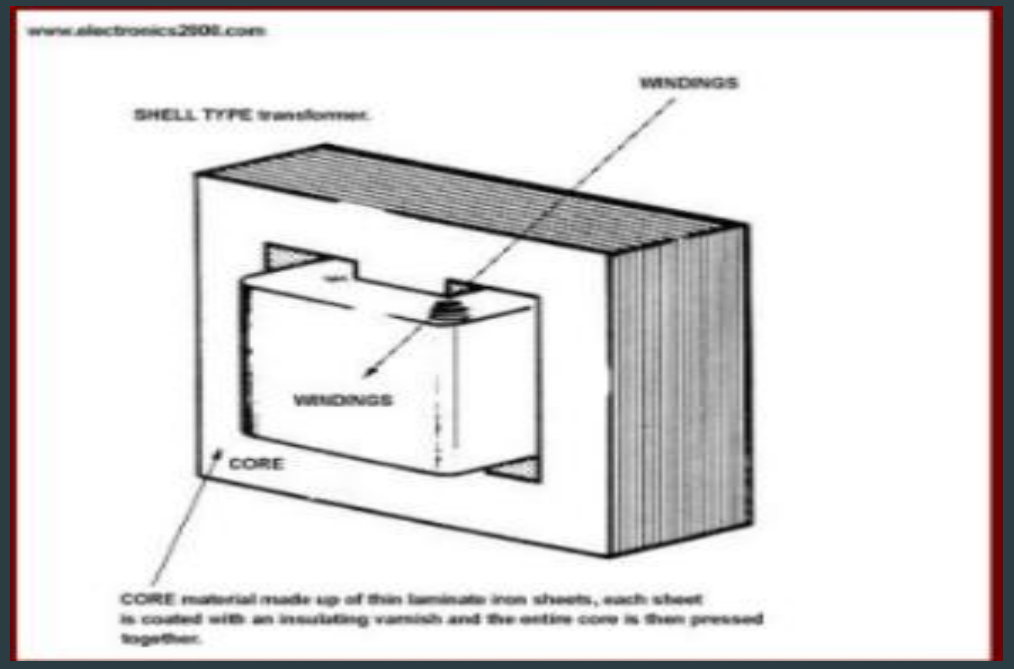
Types of Transformer

- Core Type Transformer
- In the Core type the primary and secondary windings are placed on each side of the core.



Types of Transformer

- In Shell type transformers the LV & HV windings are sandwiched between each other.
- shell type has three limbs.



Basis for Comparison	Core Type Transformer	Shell Type Transformer
Definition	The winding surround the core.	The core surround the winding.
Lamination Shape	The lamination is cut in the form of the L strips.	Lamination are cut in the form of the long strips of E and L.
Cross Section	Cross-section may be square, cruciform and three stepped	The cross section is rectangular in shape.
Copper Require	More	Less
Other Name	Concentric Winding or Cylindrical Winding.	Sandwich or Disc Winding
Limb	Two	Three
Insulation	More	Less
Flux	The flux is equally distributed on the side limbs of the core.	Central limb carry the whole flux and side limbs carries the half of the flux.
Winding	The primary and secondary winding are placed on the side limbs.	Primary and secondary windings are placed on the central limb
Magnetic Circuit	Two	One
Maintenance	Easy	Difficult

Types of Transformer

- **Step Up Transformer**
- A transformer in which voltage across secondary is greater than primary voltage is called a step-up transformer.
- In this type of transformer, Number of turns in secondary coil is greater than that in Primary coil, so this creates greater voltage across secondary coil to get more output voltage than given through primary coil.
- **STEP DOWN TRANSFORMER**
- A transformer in which voltage across secondary is lesser than primary voltage is called a step-down transformer.
- •In this type of transformer, Number of turns in secondary coil is lesser than that in Primary coil, so this creates lesser voltage across secondary coil, so we get low output voltage than given through primary coil.

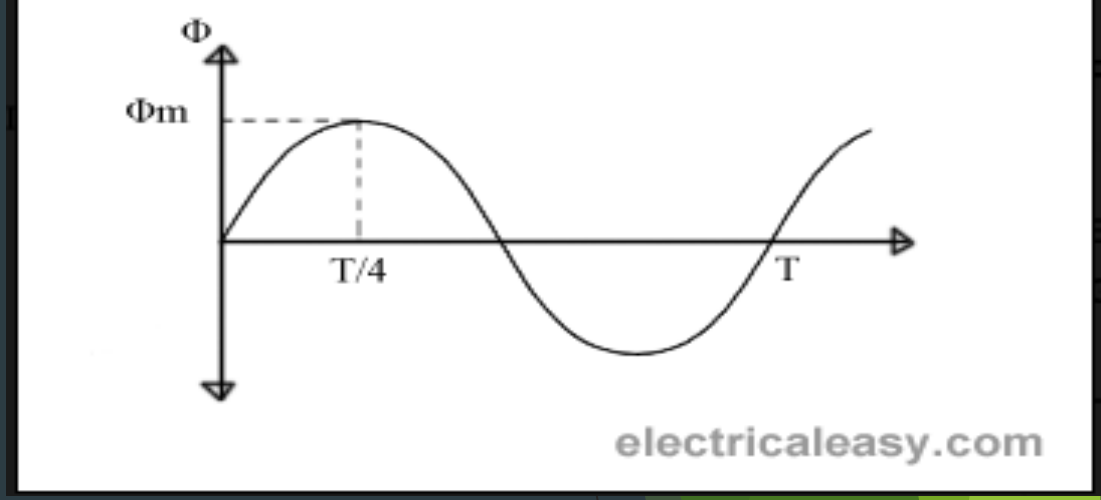
Various Transformer

- A wide variety of transformer designs are used for different applications.
- Auto-transformer.
- Poly-phase transformer.
- Leakage transformer.
- Resonant transformer.
- Instrument transformers

Characteristics of Ideal Transformer

- No winding resistance.
- No leakage flux i.e., the same flux links both the windings
- no iron losses (i.e., eddy current and hysteresis losses) in the core

EMF Equation of 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)
- average rate of change of flux = Φm /(T/4) = Φm /(1/4f)
- Therefore, average rate of change of flux = 4f Φm
- Now,
- Induced emf per turn = rate of change of flux per turn
- Therefore, average emf per turn = 4f Φm

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- Form factor = RMS value / average value
- RMS value of emf per turn = 1.11 x 4f Φm = 4.44f Φm.

- **Voltage Transformation Ratio (K)**

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

Where, K = constant This constant K is known as **voltage transformation ratio**.

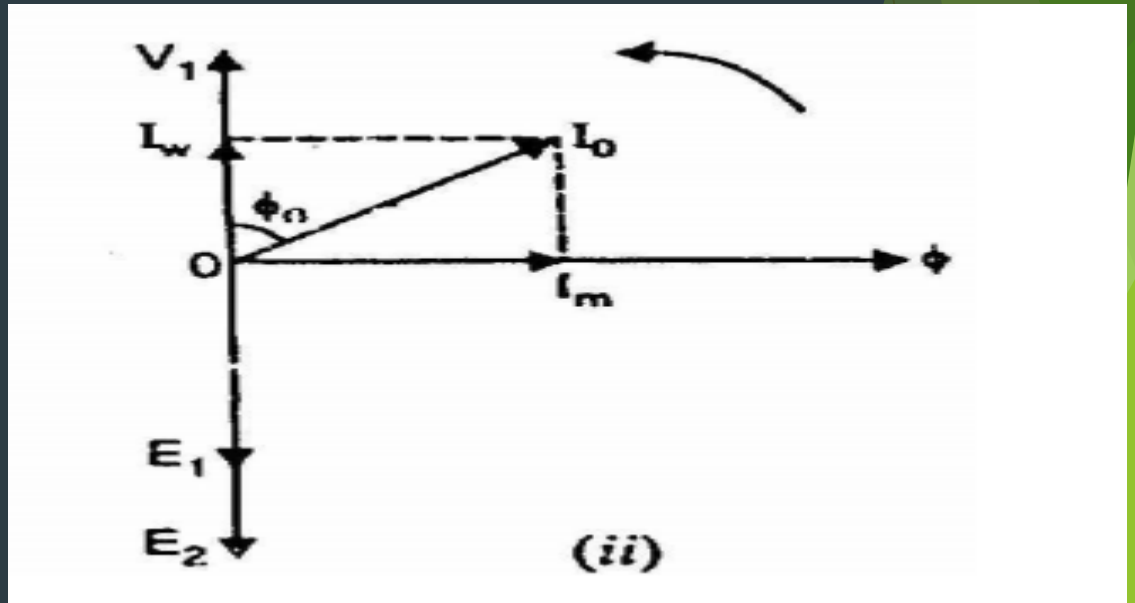
If $N_2 > N_1$, i.e. $K > 1$, then the transformer is called step-up transformer.

If $N_2 < N_1$, i.e. $K < 1$, then the transformer is called step-down transformer.

Transformer on No-Load

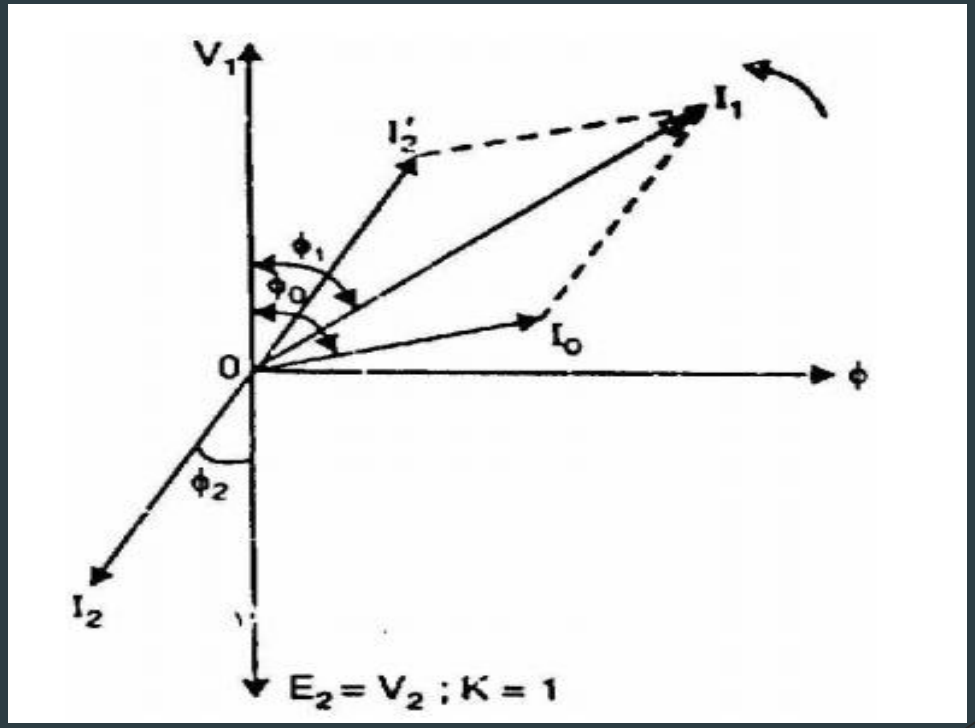
Why copper loss is low at no-load conditions?

- At the no-load condition, a very little amount of current flow through the transformer. This current is known as energized current.
- This current has two components (i) magnetizing current (ii) iron loss component
- At no-load condition, copper loss is low which can be negligible.

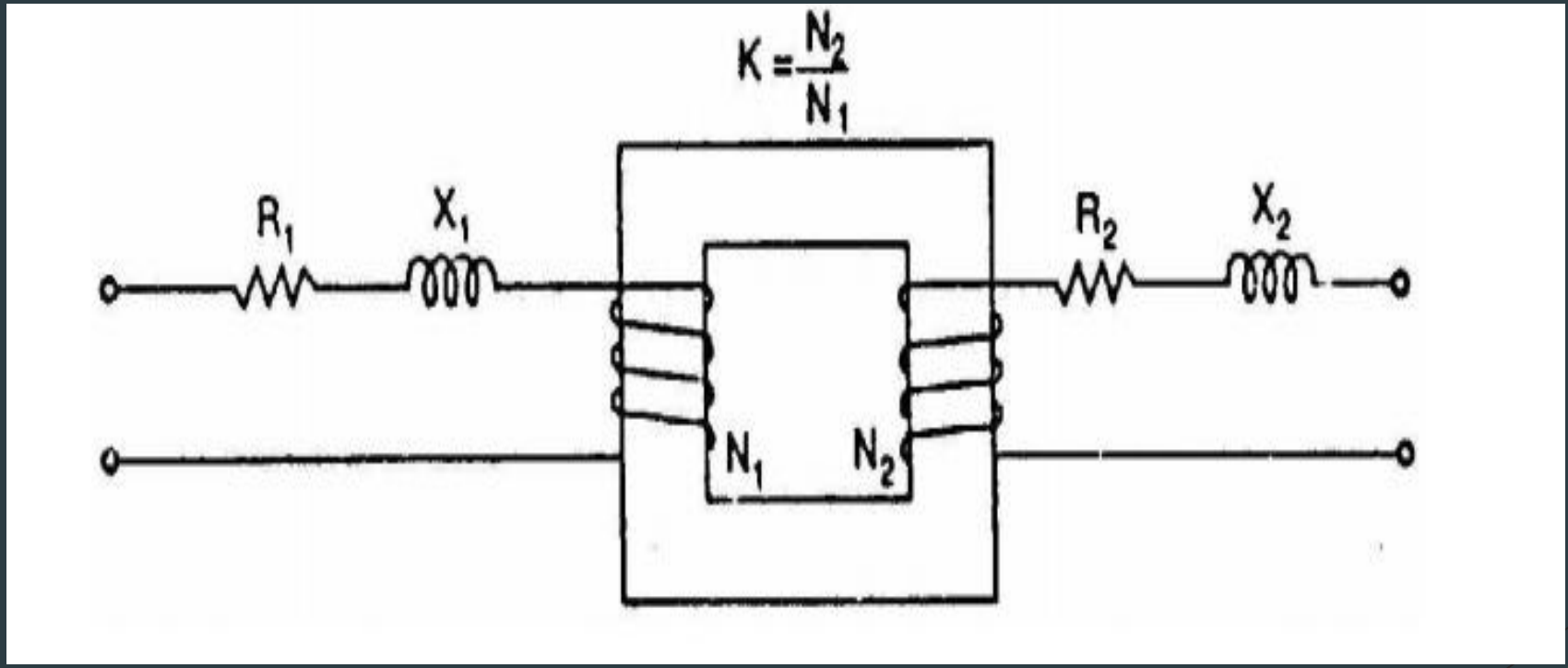


Transformer on Load

- With increasing load on secondary, the current in primary will increase.
- Under loaded condition, The primary current is the vector sum of I’2 and I1.



Equivalent Circuit Diagram



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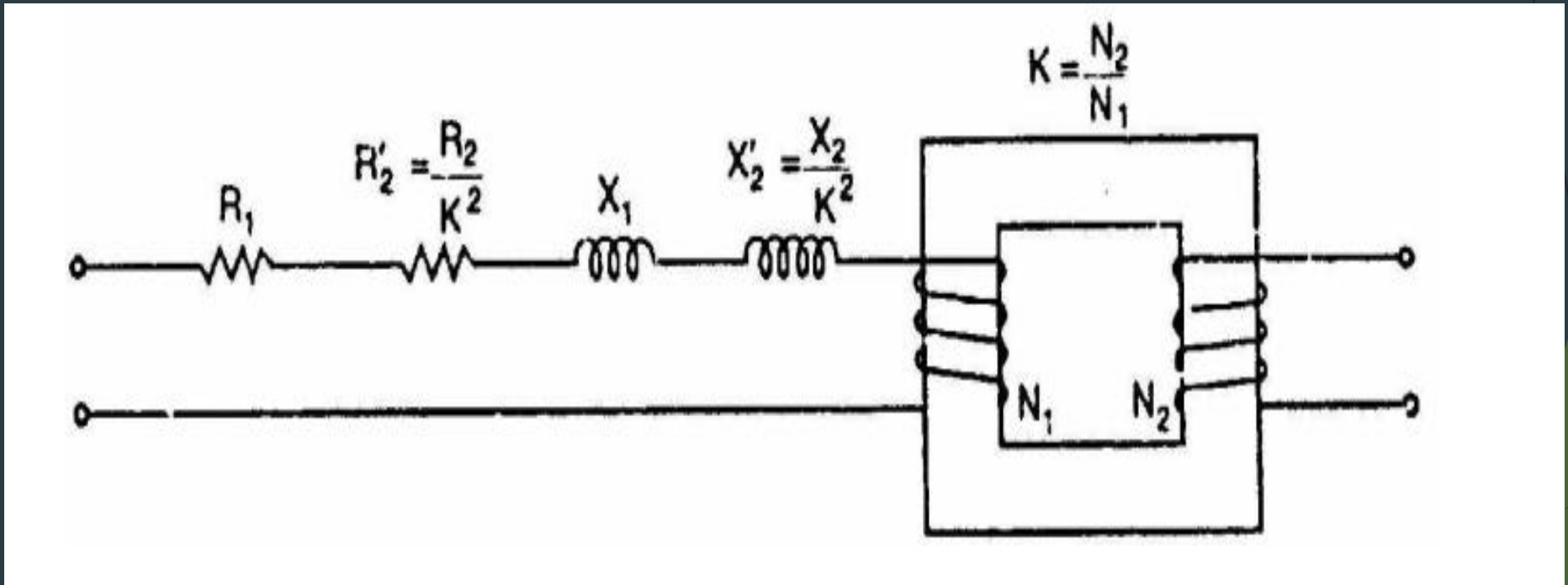
Referred to Primary:



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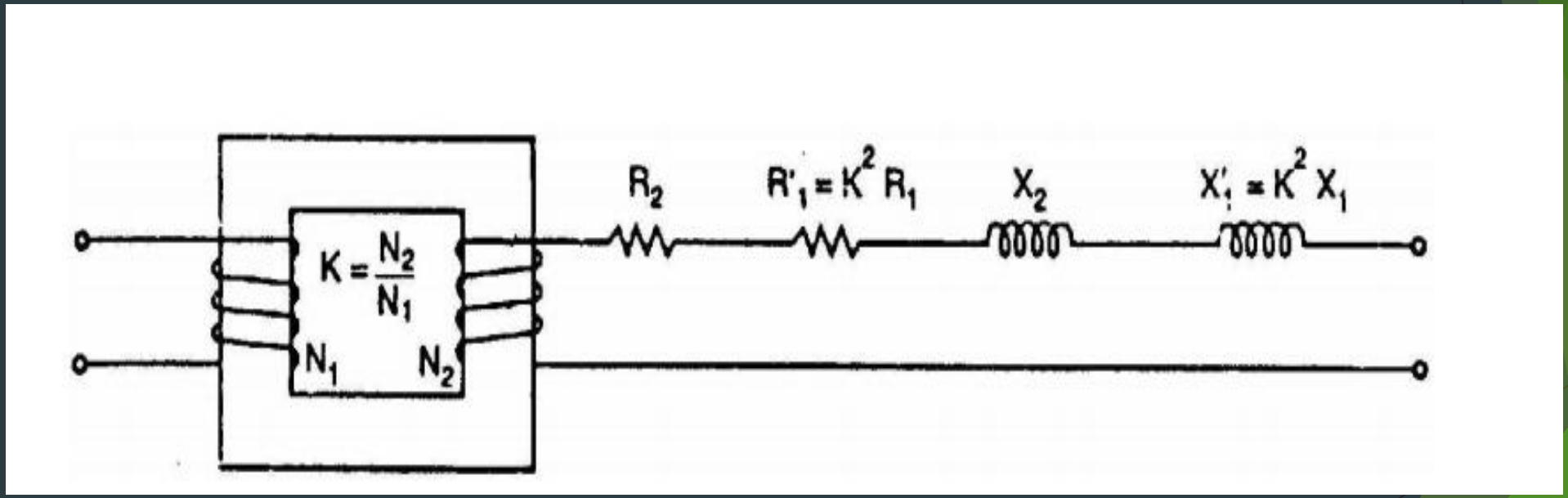
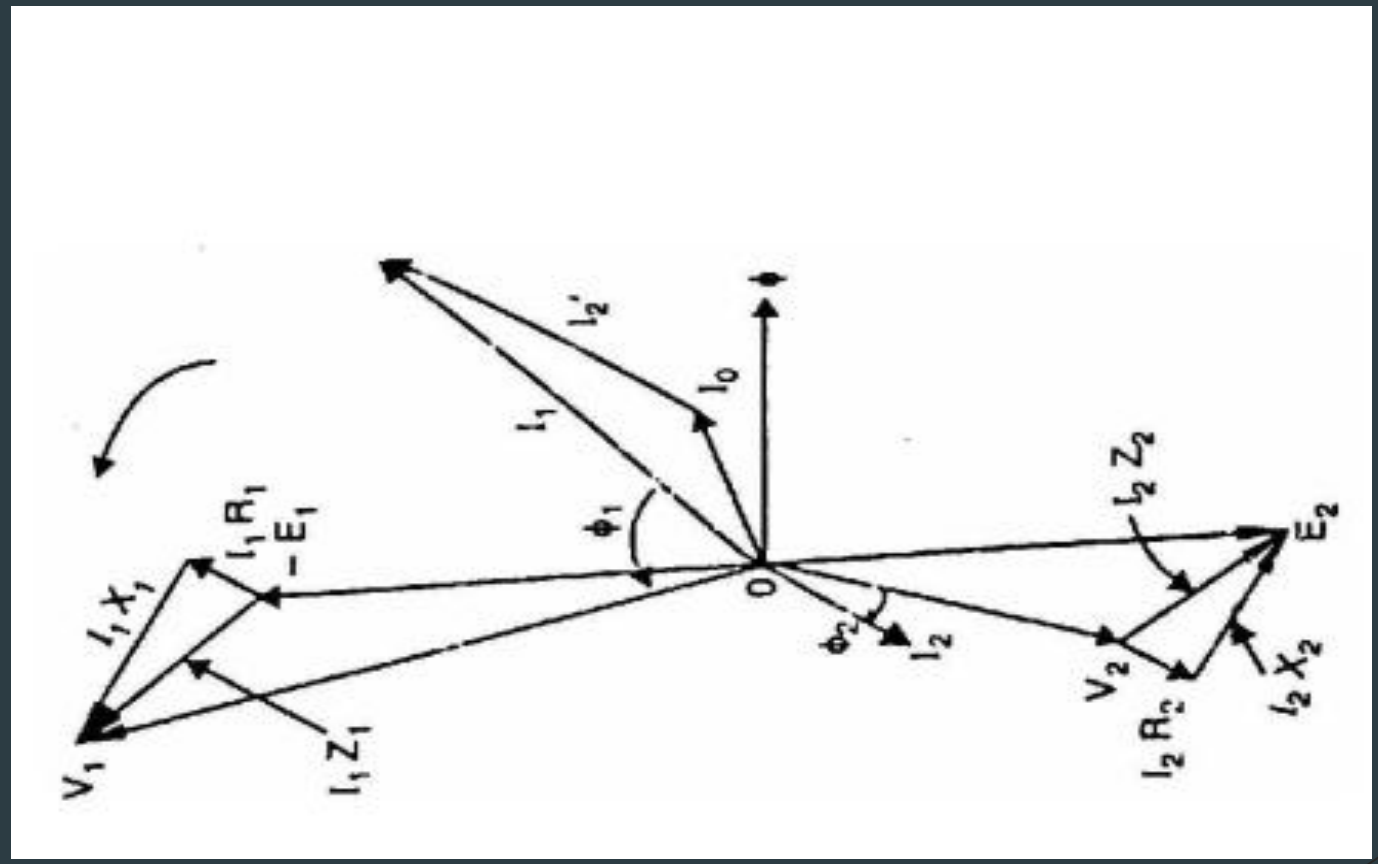
Referred to Secondary:



Full Load Phasor Diagram



Losses of Transformer

- Two types of losses can be found in transformer.
- Core loss and Copper Loss
- Core loss depends on voltage.
- Copper loss depends on current.

- **Why Transformer rating in KVA?**