Basic Electrical Engineering (TEE 101)

Lecture 42: Practical Transformer on Load – Part 1

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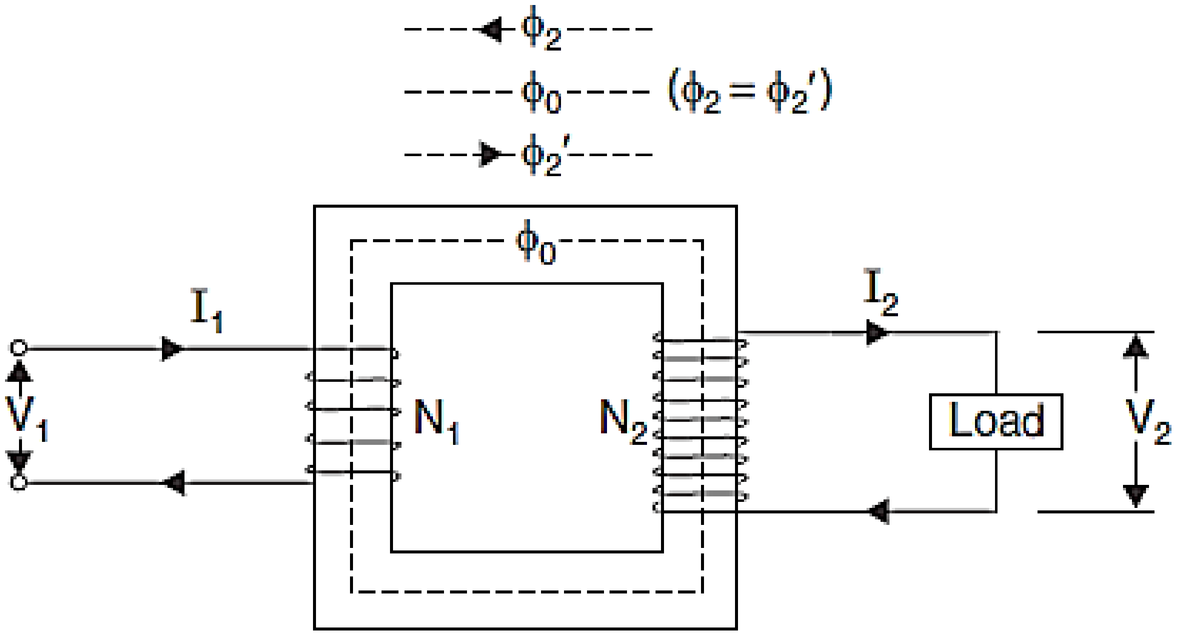
Content

This lecture covers:

- **Introduction to Transformer on Load**
- **Winding Resistance, Leakage Reactance**
- **Equivalent Circuit of Practical Transformer on Load**

Introduction

The transformer is said to be loaded when the secondary circuit of a transformer is completed through an impedance or load.



The secondary current I_2 sets up its own ampere-turns (= N_2I_2) and creates its own flux φ_2 opposing the main flux φ_0 created by no-load current I_0.

The opposing secondary flux φ_2 weakens the primary flux φ_0 momentarily hence primary counter or back e.m.f. E_1 tends to be reduced. V_1 gains the upper hand over E_1 momentarily and hence causes more current to flow in primary.

Let this additional primary current be I_2'. It is known as *load component of primary current.*

The additional primary m.m.f. N_1I_2' sets up its own flux φ_2' which is in opposition to φ_2 (but is in the same direction as φ_0) and is equal to it in magnitude. Hence they *cancel* each other.

Thus we find that the magnetic effects of secondary current I_2 are immediately neutralized by the additional primary current I_2' which is brought into existence exactly at the same instant as I_2.

From the discussion it can be concluded that :

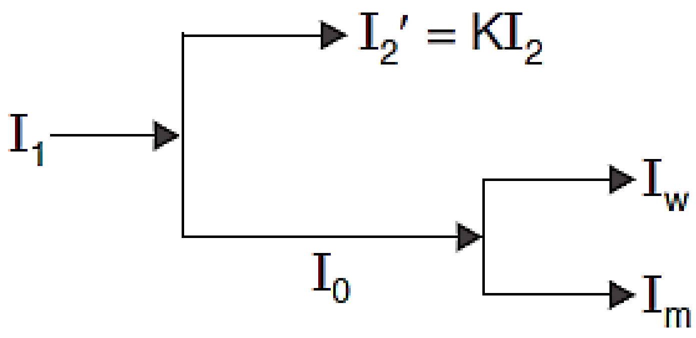
- Whatever be the load conditions, the *net flux passing through the core is approximately the same as at no-load*.
- Since the core flux remains constant at all loads, the core *loss almost remains constant under different loading conditions*.

Since $\phi_2 = \phi_2'$

$\therefore$ $N_2 I_2 = N_1 I_2'$

$$I_2' = \frac{N_2}{N_1} \times I_2 = KI_2 \qquad \left(\because \frac{N_2}{N_1} = K\right)$$

The total primary current is the vector sum of I_0 and I_2' ; the current I_2' is in *antiphase* with I_2 and K times in magnitude. The components of primary current can be shown as below :

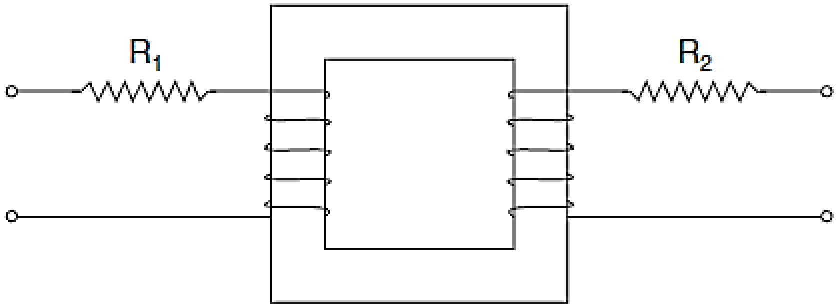


Winding Resistance and Leakage Reactance

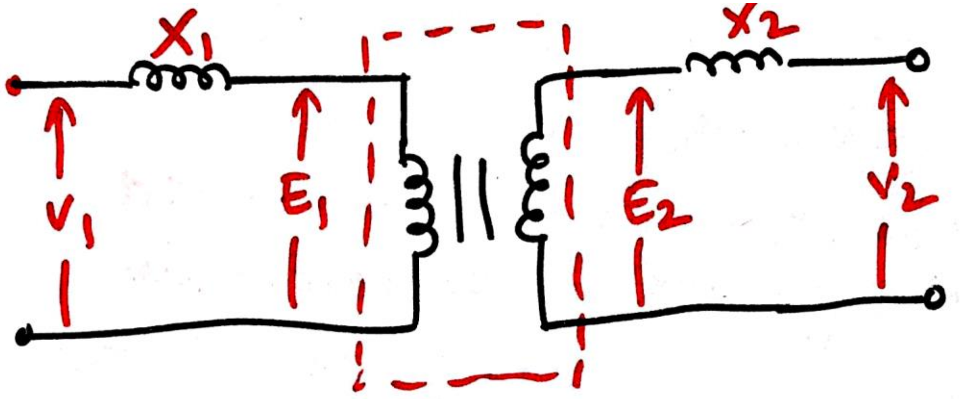
In an ideal transformer it is assumed that windings have got no resistance and there is no leakage flux. But in actual practice it is not possible to have an ideal transformer.

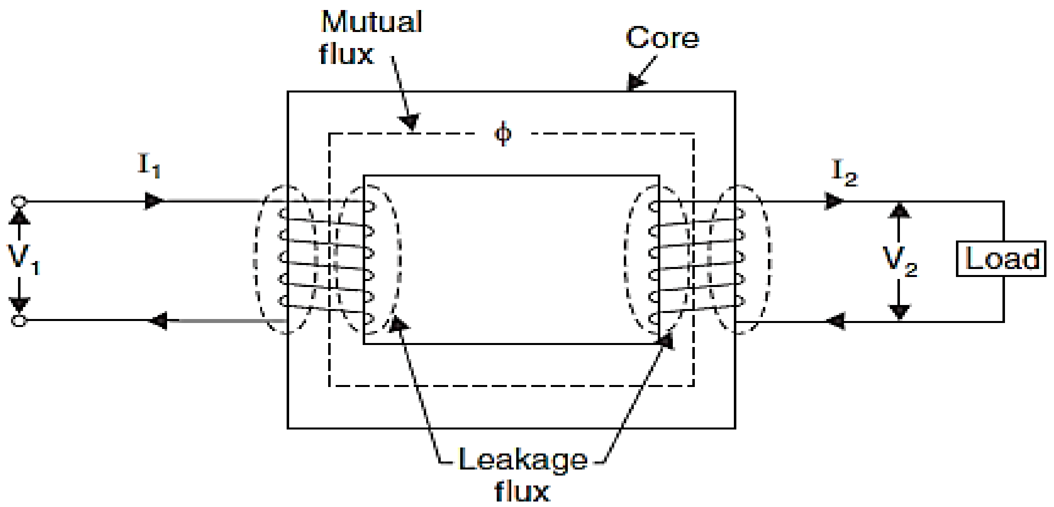
Resistance. In an actual transformer the primary as well secondary winding possess some resistance due to which some voltage drop takes place in them.

Magnetic leakage. Magnetic flux cannot be confined into a desired path. The greater portion of the flux (*i.e.*, the mutual flux) remains confined to the core and links both the windings but a small portion, called the *leakage flux*, completes its path through the air surrounding the coils.

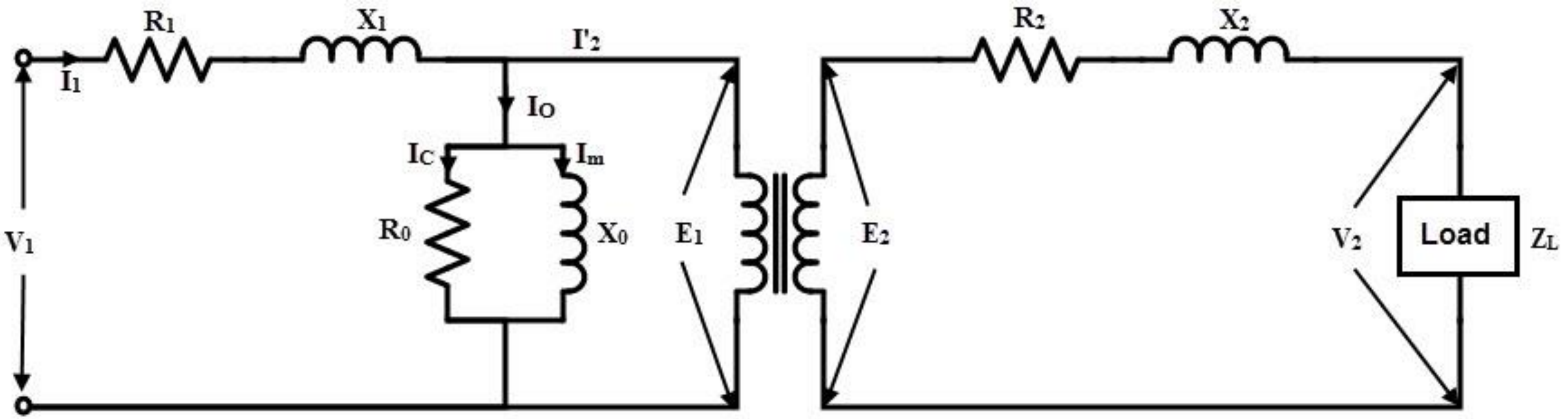


- The reactance corresponding to this primary leakage inductance (*i.e.*, $2\pi f \times$ primary leakage inductance) is known as primary leakage reactance $X1$.
- Similarly the effect of secondary leakage flux may be simulated by a secondary leakage inductance and the corresponding leakage reactance $X2$.





Equivalent Circuit of Practical Transformer on Load



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Thank You