4-8 Phasor Diagram for A Transformer on Load:

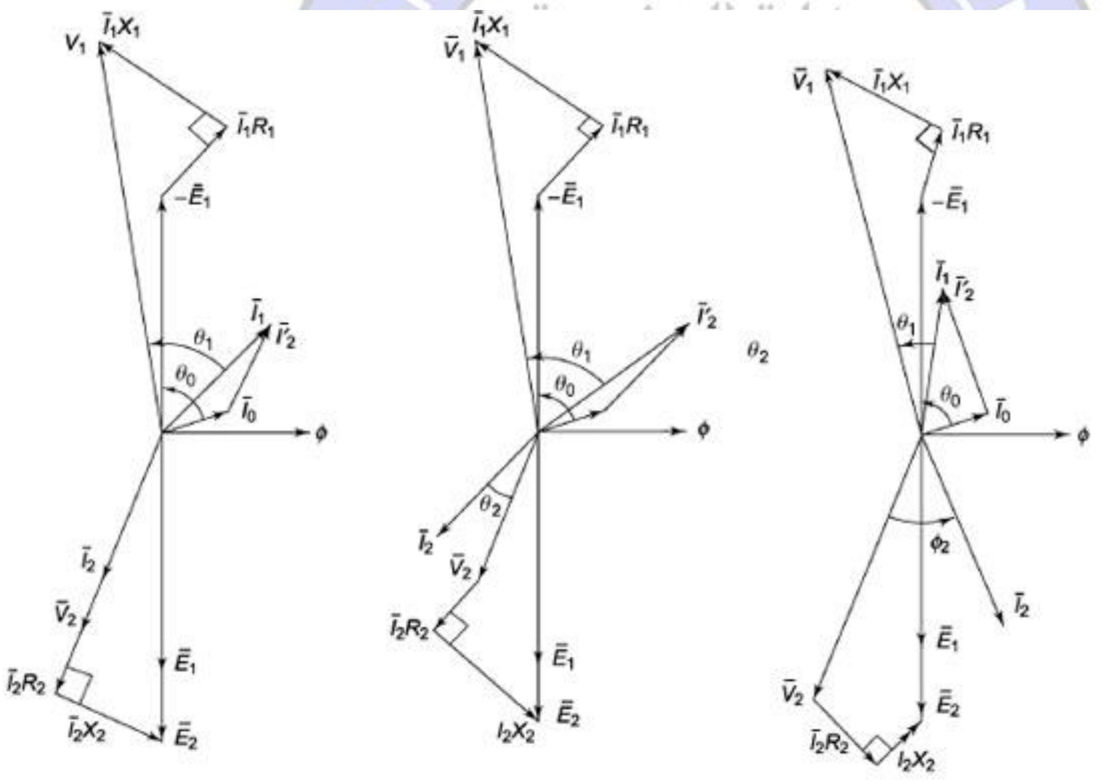
For convenience let us assume an equal number of turns on the primary and secondary windings, so that $E_1 = E_2$. Both E_1 and E_2 lag the flux by 90º as shown in fig (10) and $\grave{V}_1$ represents the voltage applied to the primary to neutralized the induced e.m.f E_1 , and is therefore equal and opposite to the latter. The general case of a load having a lagging P.f by 45º then

$I_1\ R_1$= Voltage drop due to primary resistance.

$I_2\ R_2$= Voltage drop due to secondary resistance.

$I_1\ X_1$= Voltage drop due to primary leakage reactance.

$I_2\ X_2$= Voltage drop due to secondary leakage reactance.



(a) Unity pf (b) Lagging pf (c) Leading pf

4-9 Equivalent Resistance:

A fig (5) is shown a transformer whose primary and secondary windings have resistance of R_1 and R_2 respectively. At would how be shown that the resistance of the two windings can be transferred to any on of the two windings. The advantage of concentrating both of the resistance in one winding is that it makes calculations very simple and easy because on has then two works in one winding only. As will be proved that the resistance of R2 in secondary is equivalent to $\frac{R_2}{K^2}$ in primary. The value $\frac{R_2}{K^2}$ will be denoted by $\grave{R}_2$ – the equivalent secondary resistance referred primary. The copper losses in secondary is $I_2^2\ R_2$. This loss is supplied by primary which takes a current of I_1 if $\grave{R}_2$ is the equivalent resistance in primary which would are caused the same loss as R_2 in secondary, then:

$I_1^2\grave{R}_2 = I_2^2 R_2$ or $\grave{R}_2 = (\frac{I_2}{I_1})^2\ R_2$

$\frac{I_2}{I_1} = \frac{1}{K} \rightarrow \grave{R}_2 = \frac{R_2}{K^2}$

And $I_1^2\ R_1 = I_2^2\ \ Or\ \ \grave{R}_1 = (\frac{I_1}{I_2})^2\ R_1$

$\frac{I_1}{I_2} = K \ \rightarrow\ \grave{R}_1 = K^2\ R_1$

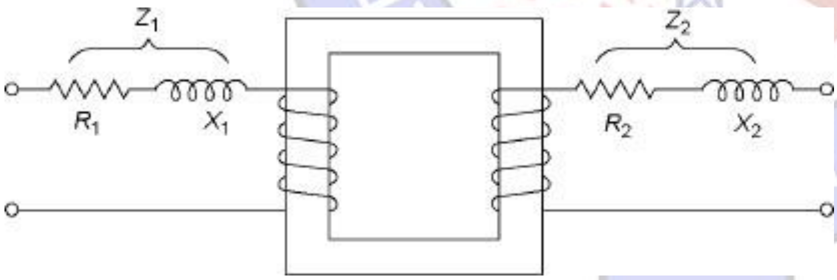


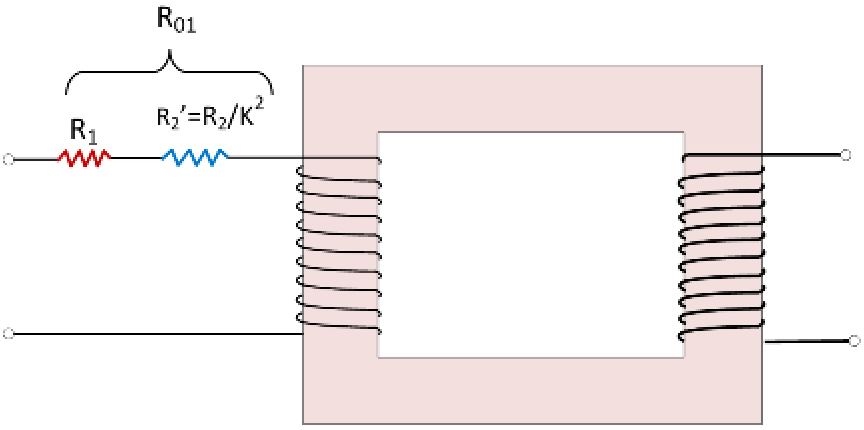
Fig (6, a), secondary resistance has been transferred to primary side leaving secondary circuit resistance less. Resistance $R_1 + \grave{R}_2 = R_1 + \frac{R_2}{K^2}$ is known as equivalent or effective resistance of the transformer as referred to primary and may be designated as R_{01}:

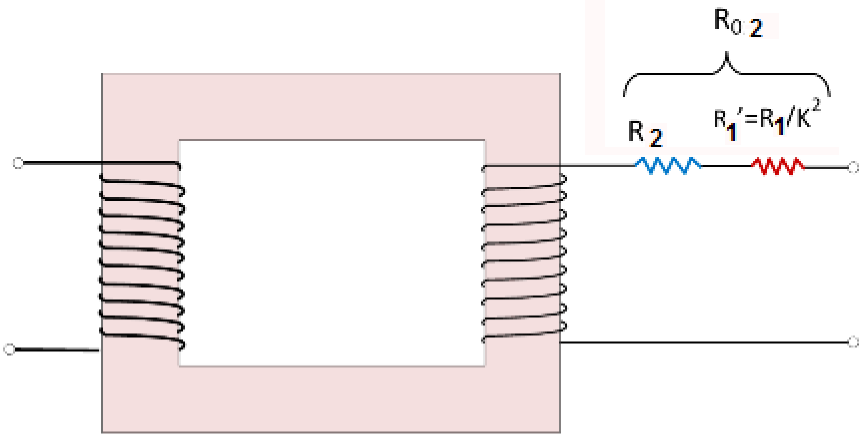
$$R_{o1} = R_1 + \grave{R}_2 = R_1 + \frac{R_2}{K^2}$$

Similarly, the equivalent resistance of the transformer as referred to secondary is:

$$R_{o2} = R_2 + \grave{R}_1 = R_2 + R_1\ K^2$$

As shown in fig (6, b)





4-10 Equivalent Circuit of A Transformer:

The behavior of a transformer may be conveniently considered by assuming it to be equivalent to an ideal transformer, a transformer having no losses and no magnetic leakage and an from core of infinite permeability requiring no magnetizing current, and then allowing for the imperfections of the actual transformer by means of additional circuits or impedance inserted between the supply and the primary winding and between the secondary and the load, thus in fig(9).

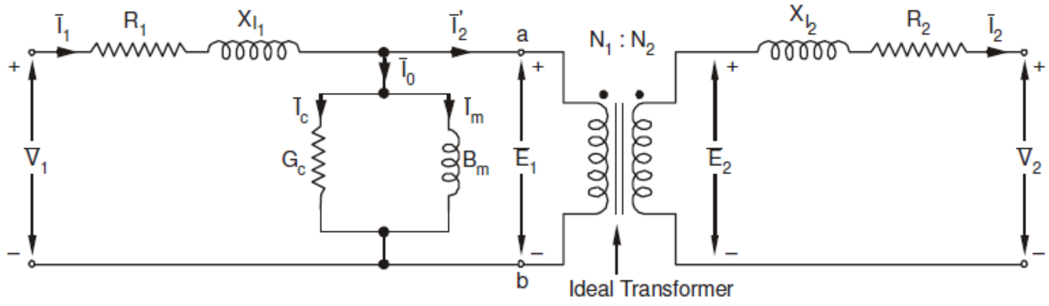


Fig. (9) Equivalent circuit of a transformer

4-11 Approximate Equivalent cct. of Transformer:

Since the no-load of transformer is only about 3.5 per cent of the full-load primary current, we can omit the parallel circuits R and X in fig (9) without introducing an appreciable error when we are considering the behavior of the transformer on full-load. Thus, we have the equivalent cct. Of fig (11)