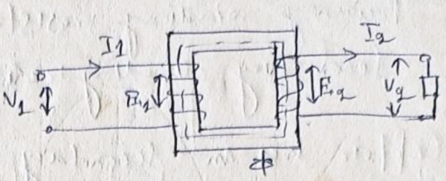
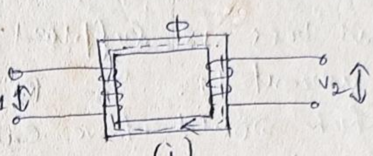
Transformer on load :-

When the secondary is loaded, the secondary current I_2 is set up.

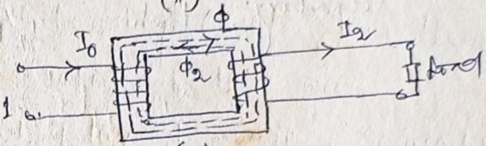


The secondary current sets up its own m.m.f. $(= N_2 I_2)$ and hence flux ϕ_2, which is in opposition to main flux ϕ, which is due to I_0.

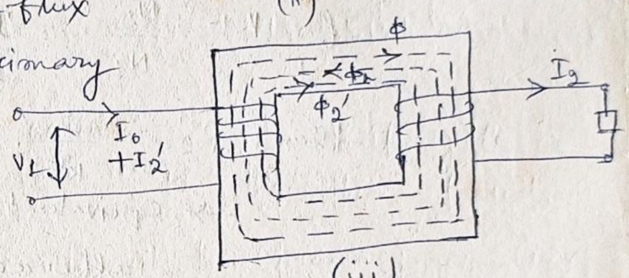


(i)

The opposing secondary flux ϕ_2 weakens the primary flux ϕ momentarily, hence primary back e.m.f. E_1 tends to be reduced. For a moment V_1 becomes more than E_1 and hence, causes more current to flow in the primary.

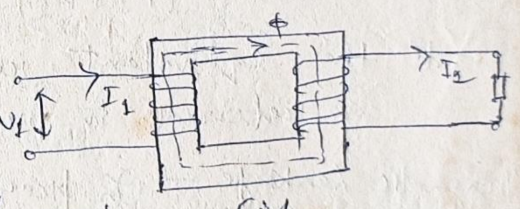


(ii)



(iii)

Let, the additional primary current is I_2'.



(iv)

The additional primary m.m.f. $N_1 I_2'$ sets up its own flux ϕ_2', which is in opposition to ϕ_2 and is equal to ϕ_2 in magnitude. Hence, ϕ_2 and ϕ_2' cancel each other. So, we find that the magnetic effects of secondary current I_2 are immediately neutralised by the additional primary current I_2'.

Hence, whatever the load conditions, the net flux passing through the core is approximately the same as no-load.

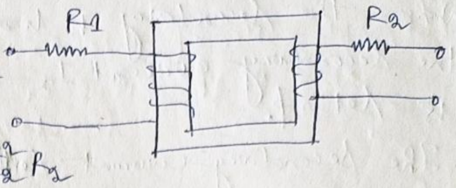
Due to constancy of core flux, the core loss is practically constant.

$$N_1 I_2' = N_2 I_2 \Rightarrow I_2' = \frac{N_2}{N_1} \cdot I_2 = K I_2$$

Hence, on load condition, the primary winding has two currents in it — I_0 and I_2'.

Equivalent Resistance :-

Let, R_1 = Primary winding resistance
R_2 = Secondary winding resistance



Copper loss in secondary $= I_2^2 R_2$

This loss is supplied by primary which takes a current I_1. If R_2' is equivalent resistance in primary which would have caused the same loss as R_2 in secondary, then $I_1^2 R_2' = I_2^2 R_2$

or, $R_2' = \left(\frac{I_2}{I_1}\right)^2 \cdot R_2$

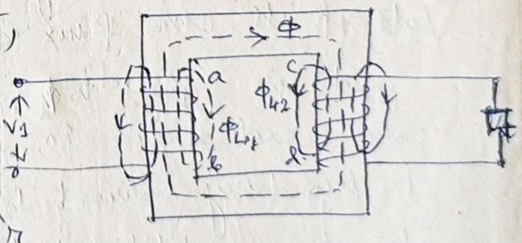
If $K = \frac{N_2}{N_1} = \frac{I_1}{I_2}$, [Neglecting no-load current I_0]

then $R_2' = \frac{1}{K^2} \cdot R_2$.

→ equivalent secondary resistance as refferred to primary.

The resistance $(R_1 + R_2')$ i.e., $\left(R_1 + \frac{R_2}{K^2}\right)$ is known as the equivalent resistance of the transformer as referred to primary.

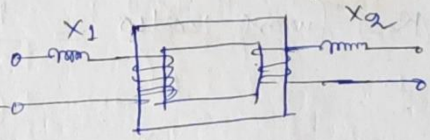
Magnetic Leakage :- In practice, all the flux linked with primary does not link the secondary, but a part of it, i.e., ϕ_{L1} completes its magnetic circuit by passing through air, rather than around through the core. This leakage flux is produced due to primary m.m.f. This flux is known as primary leakage flux and is proportional to the primary ampere turns alone. ϕ_{L1} induces an e.m.f. in primary.



Similarly, secondary ampere-turns acting across points c and d, set up leakage flux ϕ_{L2} which is linked with secondary winding alone. ϕ_{L2} induces an e.m.f. e_{L2}

At no-load and light loads, the primary and secondary ampere-turns are small, hence leakage fluxes are negligible.

So, a transformer with magnetic leakage is equivalent to an ideal transformer with inductive coils connected in both primary and secondary circuits, such that voltage drop in each series coil is equal to that produced by leakage flux.



X_1 and X_2 - are called primary and secondary leakage reactances.