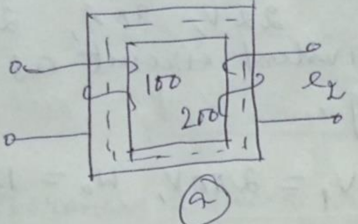
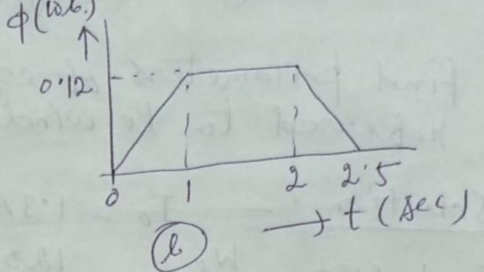
(*) The nature of mutual flux variation in the core of a transformer is shown in the following figure. Sketch the nature of variation of the induced emf (e_2) in the secondary winding.





Solution :- $e_2 = -N_2 \frac{d\phi}{dt}$

For $0 < t < 1$, $\frac{d\phi}{dt} = \frac{0.12 - 0}{1 - 0} = \frac{0.12}{1} = 0.12$

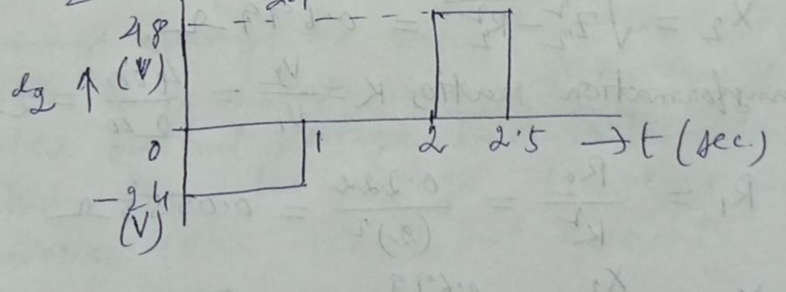
$\therefore e_2 = -N_2 \frac{d\phi}{dt} = -200 \times 0.12 = -24$ V.

For $1 < t < 2$, $\frac{d\phi}{dt} = 0$

$\therefore e_2 = -N_2 \frac{d\phi}{dt} = 0.$

For $2 < t < 2.5$, $\frac{d\phi}{dt} = \frac{0 - 0.12}{2.5 - 2} = \frac{-0.12}{0.5} = -0.24$ V.

$\therefore e_2 = -N_2 \frac{d\phi}{dt} = -200 \times (-0.24) = 48$ V.



(*) A 10 KVA, 200/400V, 50 Hz Single-phase transformer gave the following test results:

oc test (lv winding open) : 200V, 1.3 A, 120 W.

sc test (lv winding short-circuited): 22 V, 30 A, 200 W.

Find parameters of equivalent circuit as referred to lv winding.

Solution :- $I_0 = 1.3A$, $V_1 = 200V$, $W_0 = 120W$.

From oc test :- $\cos\phi_0 = \frac{W_0}{V_1 I_0} = \frac{120}{200 \times 1.3} = 0.4615$

$\therefore I_c = I_0 \cos\phi_0 = 1.3 \times 0.4615 = 0.6$ A.

$I_m = I_0 \sin\phi_0 = 1.15$ A.

$\therefore R_0 = \frac{V_1}{I_c} = \frac{200}{0.6} = 333.3\ \Omega$

$X_0 = \frac{V_1}{I_m} = \frac{200}{1.15} = 173.42\ \Omega$

From sc test :- $Z_{02} = \frac{V_{sc}}{I_{sc}} = \frac{22}{30} = 0.733\ \Omega$

$R_2 = \frac{W_{sc}}{I_{sc}^2} = \frac{200}{(30)^2} = 0.222\ \Omega$

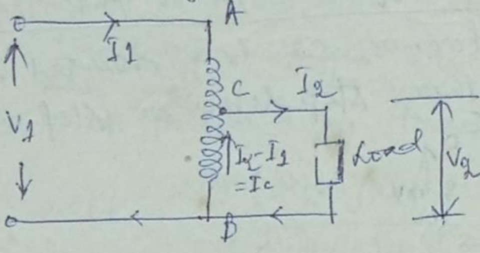
$\therefore X_2 = \sqrt{Z_{02}^2 - R_2^2} = 0.699\ \Omega$

Transformation ratio, $K = \frac{V_2}{V_1} = \frac{400}{200} = 2$

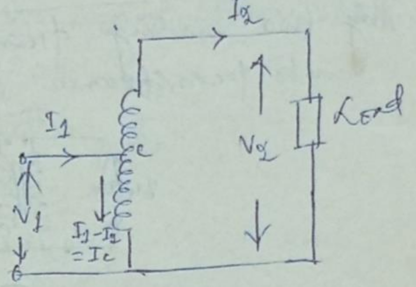
$\therefore R_1 = \frac{R_2}{K^2} = \frac{0.222}{(2)^2} = 0.0555\ \Omega$

$X_1 = \frac{X_2}{K^2} = \frac{0.699}{(2)^2} = 0.175\ \Omega$

Auto transformer :- It is a transformer with one winding only, part of this being common to both primary and secondary.



(a)



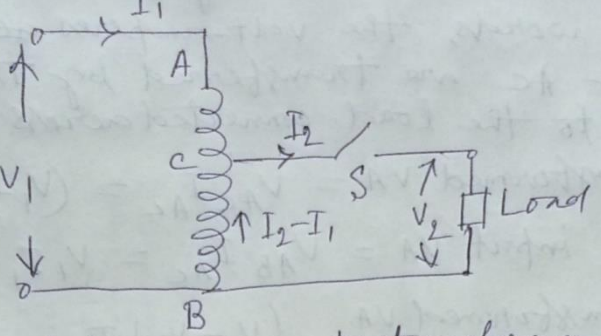
(b)

AB – is primary winding having N_1 – turns.
BC – is secondary winding having N_2 – turns.

Negtecting iron losses and no-load current,

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

Auto-transformer



Differences between an auto-transformer and resistive potential divider :-

1. A resistive potential divider cannot step up the voltage, where as it is possible in an auto-transformer.
2. The potential divider has more losses, and is, therefore, less efficient.
3. In a potential divider, almost entire power to load flows by conduction, where as, in auto-transformer, a part of the power is conducted and the rest is transferred to load by transformer action.
4. In a potential divider, the input current must always be more than the output current, this is not so in an auto-transformer. If the output voltage in auto-transformer is less than the input voltage, the load current is more than the input current.

Transformed and conducted VA :-

In the above figure, $I_{BC} = I_2 - I_1$

current in $AC = I_1$

$\therefore$ mmf of winding $AC = I_1(N_1 - N_2)$

$= I_1 N_1 - I_1 N_2 = I_2 N_2 - I_1 N_2$

$= (I_2 - I_1) N_2 = I_{BC} N_2$

$=$ mmf of winding BC.

It is, therefore, seen that the transformer action takes place between winding AC and winding BC. In other words, the volt-amperes ~~aer~~ across winding AC are transferred by transformer action to the load connected across winding BC.

$\therefore$ Transformed VA $= V_{AC} I_{AC} = (V_1 - V_2) I_1$

Total input VA $= V_{AB} I_{AC} = V_1 I_1 =$ output VA.

$$\therefore \frac{\text{Transformed VA}}{\text{Input VA}} = \frac{(V_1 - V_2) I_1}{V_1 I_1} = \frac{V_1 - V_2}{V_1}$$

$$= 1 - \frac{V_2}{V_1} = 1 - K$$

Out of input volt-amperes $V_{AB} I_{AC}$, only $V_{AC} I_{AC}$ are transformed to the output by transformer action. The rest of the volt-amperes are conducted directly from the input.

$\therefore$ Conducted VA $= V_{AB} I_{AC} - V_{AC} I_{AC}$

$= (V_{AB} - V_{AC}) I_{AC} = V_{BC} I_{AC} = V_2 I_1$

$$\therefore \frac{\text{Conducted VA}}{\text{Input VA}} = \frac{V_2 I_1}{V_1 I_1} = \frac{V_2}{V_1} = K.$$

$$\therefore \frac{\text{Transformed power}}{\text{Input power}} = 1 - K$$

and $$\frac{\text{Conducted power}}{\text{Input power}} = K.$$