3.2 E.M.F EQUATION OF A TRANSFORMER

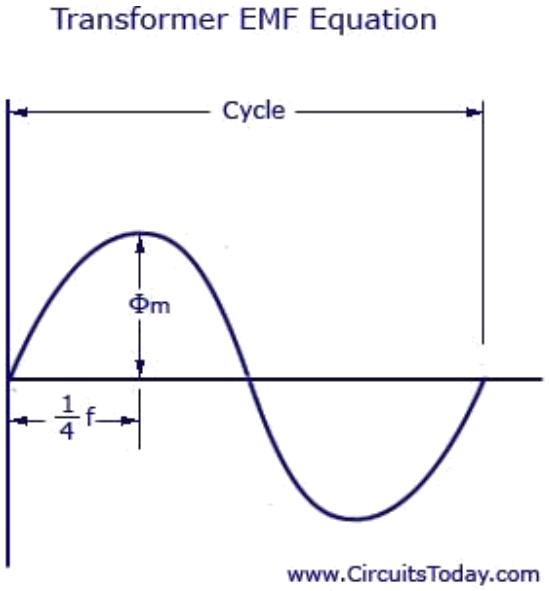

Figure 3.2 EMF Equation

[Source: "Basic Electrical and Electronics Engineering" by Kothari D.P , Page – 435]

Transformer EMF Equation Let,

N_A = Number of turns in primary

N_B = Number of turns in secondary

$Ø_{max}$ = Maximum flux in the core in webers = B_{max} X A f = Frequency of alternating current input in hertz (H_Z)

As shown in figure above, the core flux increases from its zero value to maximum value $Ø_{max}$ in one quarter of the cycle , that is in ¼ frequency second.

Therefore, average rate of change of flux = $Ø_{max}$/ ¼ f = 4f $Ø_{max}$Wb/s

Now, rate of change of flux per turn means induced electro motive force in volts. Therefore, average electro-motive force induced/turn = 4f $Ø_{max}$volt

If flux Ø varies sinusoidally, then r.m.s value of induced e.m.f is obtained by

multiplying the average value with form factor.

Form Factor = r.m.s. value/average value = 1.11

Therefore, r.m.s value of e.m.f/turn = 1.11 X 4f

$Ø_{max}$ = 4.44f $Ø_{max}$ Now, r.m.s value of induced e.m.f

in the whole of primary winding

= (induced e.m.f./turn) X Number of

primary turns Therefore,

E_A = 4.44f $N_A Ø_{max}$ = 4.44f$N_A B_m A$

Similarly, r.m.s value of induced e.m.f in secondary is E_B = 4.44f N_B $Ø_{max}$ = 4.44f$N_B B_m A$

In an ideal transformer on no load,

$V_A = E_A$ and $V_B = E_B$, where V_B is the terminal voltage

Voltage Transformation Ratio (K) From the above equations we get $E_B/ E_A = V_B/ V_A = N_B/N_A = K$

This constant K is known as voltage transformation ratio.

(1) If $N_B > N_A$, that is K>1 , then transformer is called step-up transformer.

(2) If N_B<1, that is K<1 , then transformer is known as step-down transformer.

Again for an ideal transformer, Input V_A = output V_A

$V_A I_A = V_B I_B$

Or, $I_B/I_A = V_A/V_B = 1/K$

Hence, currents are in the inverse ratio of the (voltage) transformation ratio.

Applications of a transformer

Transformers are used in most electronic circuits. A transformer has only 3 applications;

1. To step up voltage and current.
2. To Step down voltage and current

3. To prevent DC – transformers can pass only Alternating Currents so they totally prevent DC from passing to the next circuit.