

3.2 E.M.F EQUATION OF A TRANSFORMER

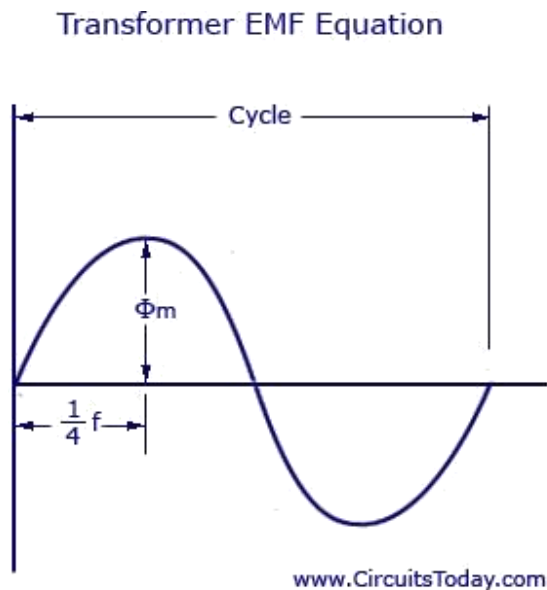


Figure 3.2 EMF Equation

[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

Φ_{max} = Maximum flux in the core in

webers = $B_{max} \times A$ f = Frequency of

alternating current input in hertz (Hz)

As shown in figure above, the core flux increases from its zero value to maximum value Φ_{max} in one quarter of the cycle , that is in $\frac{1}{4}$ frequency second.

Therefore, average rate of change of flux = $\Phi_{max} / \frac{1}{4} f = 4f \Phi_{max}$ Wb/s

Now, rate of change of flux per turn means induced electro

motive force in volts. Therefore, average electro-motive force

induced/turn = $4f \Phi_{max}$ volt

If flux Φ 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 = $1.11 \times 4f$

$\phi_{\max} = 4.44f \phi_{\max}$ 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,

$$E_A = 4.44f N_A \phi_{\max} = 4.44f N_A B_m A$$

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

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 $N_B < N_A$, that is $K < 1$, then transformer is known as step-down transformer.

Again for an ideal transformer, Input $V_A =$ output V_B

$$V_A I_A = V_B I_B$$

$$\text{Or, } I_B/I_A = V_A/V_B = 1/K$$

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.

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