(EM1-2) Transformer (1)

Aim of experiment

Study the effect of the ratio of primary to secondary coils on the output voltage.

Apparatus

AC Power Supply –Two Voltmeter –Coils of Different Number of Turns

Theory of experiment

In its simplest form, the AC transformer consists of two coils of wire wound around a core of iron, as illustrated in *figure 1*. The coil on the left, which is connected to the input alternating voltage source and has N_1 turns, is called the primary winding (or the primary). The coil on the right, consisting of N_2 turns and connected to a load resistor R is called the secondary winding (or the secondary).

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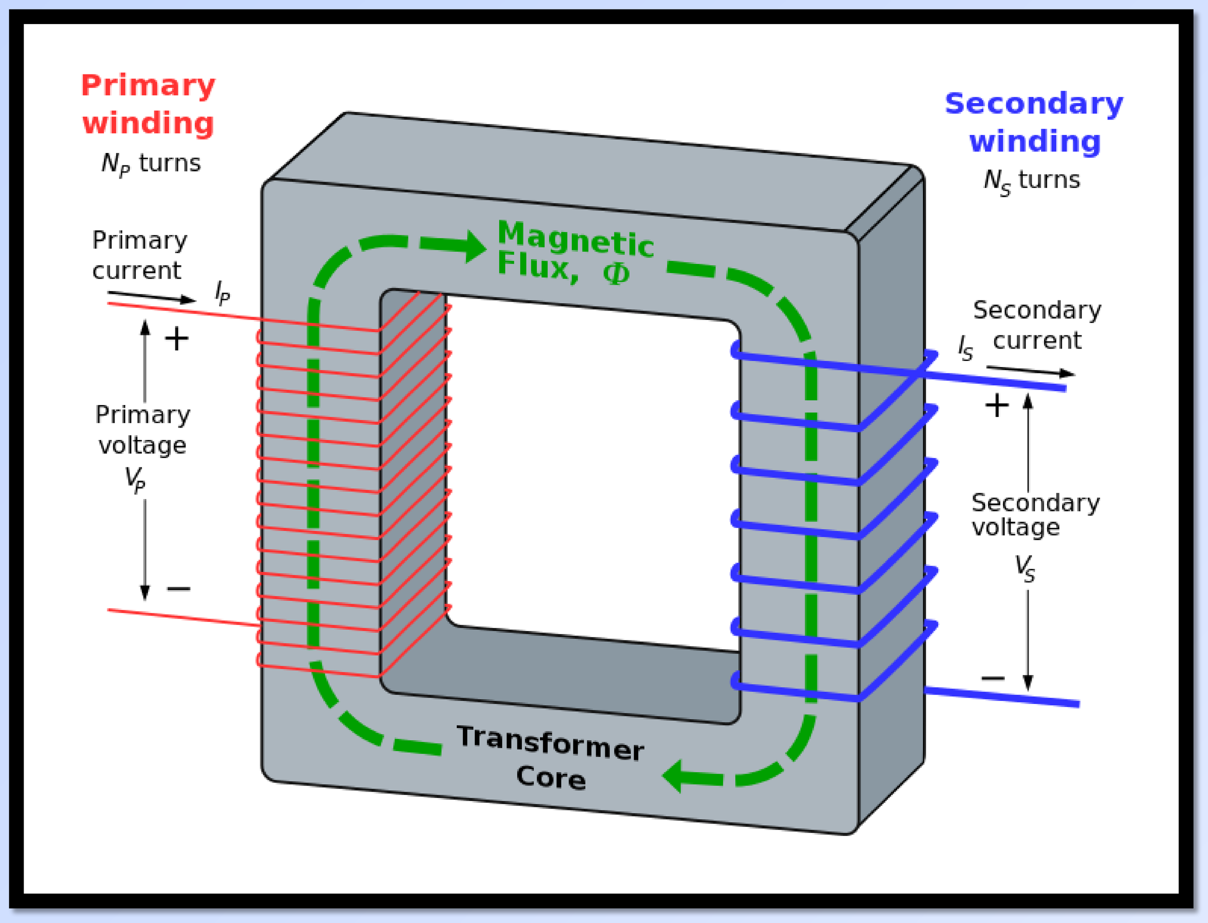

Figure 1. A sketch of a transformer showing the effect of the magnetic transformer core

The purpose of the iron core is to increase the magnetic flux through the coil and to provide a medium in which nearly all the magnetic field lines through one coil pass through the other coil. Eddy-current losses are reduced by using a laminated core. Iron is used as the core material because it is a soft ferromagnetic substance and hence reduces hysteresis losses. Transformation of energy to internal energy in the finite resistance of the coil wires is usually quite small.

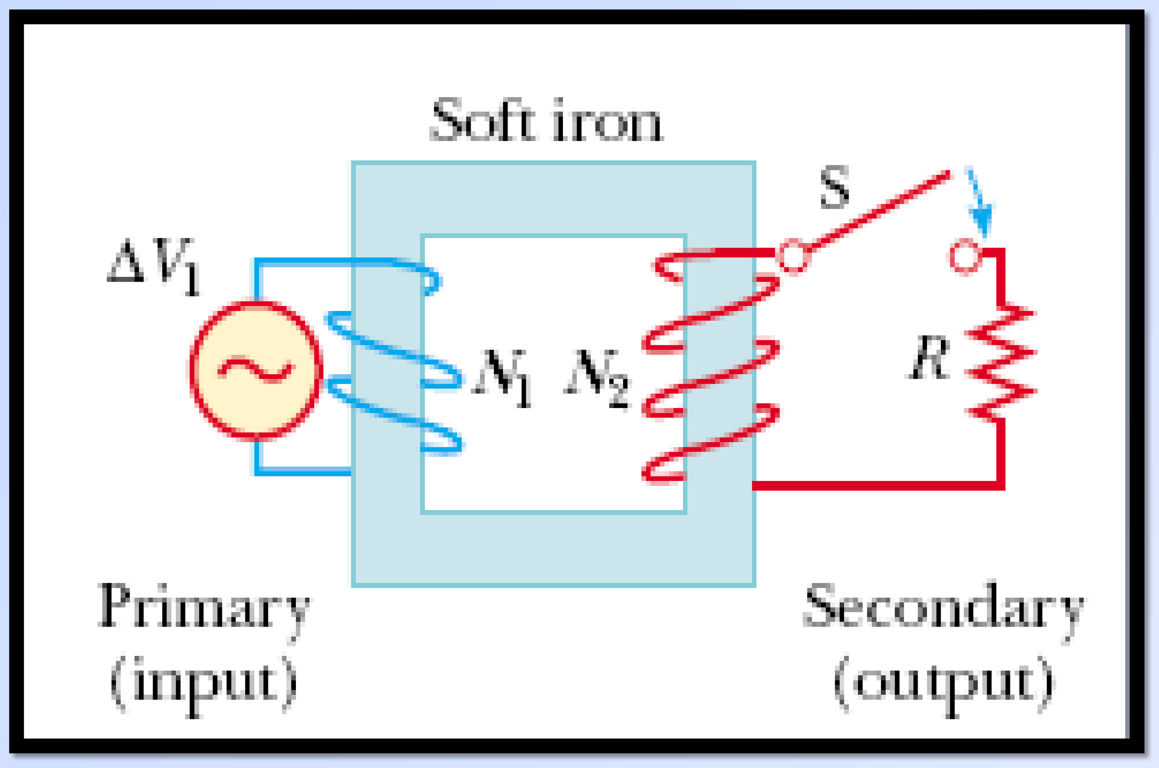

Figure 2. A circuit diagram of a transformer connected to AC primary power source, and a load resistance R, connected to the secondary coil.

Typical transformers have power efficiencies from 90% to 99%. In the discussion that follows, *figure 2*, we assume an ideal transformer, one in which the energy losses in the windings and core are zero. Faraday's law states that the voltage ΔV_1 across the primary is

$$\Delta V_1 = -N_1 \frac{d\Phi_B}{dt} \qquad (1)$$

where Φ_B is the magnetic flux through each turn. If we assume that all magnetic field lines remain within the iron core, the flux through each turn of the primary equals the flux through each turn of the secondary. Hence, the voltage across the secondary is

$$\Delta V_2 = -N_2 \frac{d\Phi_B}{dt} \qquad (2)$$

Solving Equation (1) for $d\Phi_B/dt$ and substituting the result into Equation (2), we find that

$$\Delta V_2 = \frac{N_2}{N_1} \Delta V_1 \qquad (3)$$

When $N_2 > N_1$, the output voltage ΔV_2 exceeds the input voltage ΔV_1 This setup is referred to as a step-up transformer.

When $N_2 < N_1$, the output voltage is less than the input voltage, and we have a step-down transformer.

If we draw a relation between $\frac{N_1}{N_2}$ and V_2 the constant input voltage is its slope V_1.

Procedure

1- Connect the circuit as shown in *figure 2* and apply unknown input voltage V_1.

2- For a transformer, put primary coil, N_1, and secondary coil, N_2 of initial ratio and record the corresponding output voltage V_2, and record the results. $\frac{N_1}{N_2}$

3-Vary the ratio and measure V_2 in each case.

4- Repeat the above step at least 3 times and calculate the average of the output voltage

4 - Plot the relation between $\frac{N_1}{N_2}$ on x-axis and V_{2av} on y-axis.

5- Find the slope and obtain V_1

Results

$\frac{N_1}{N_2}$	V_2 (A)			$V_{2av} \pm \Delta V$
	1	2	3	

$V_1 =$ ………….. V