Experiment 9
Transformers

Objectives:

In this experiment you will investigate the characteristics of the Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) and study its applications as:

- voltage-controlled resistor
- logic gate
- amplifier
- current source

❶ *Effect of finite magnetizing current*

Since the permeability of the magnetic material in the core is not infinite, a certain magnetizing current is required to establish a magnetic flux in the core. The effect of the finite magnetizing current can be modeled by an inductance L_M connected across the primary winding of the ideal transformer, as shown in Fig. 2.

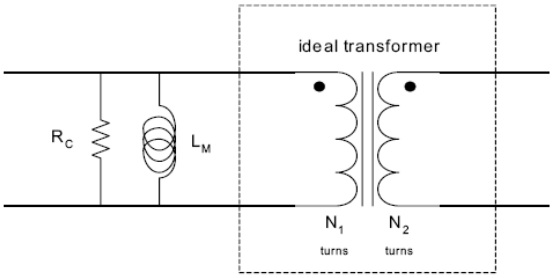

Fig. 2

❷ *Effect of core losses*

The effect of core losses may be accounted for by adding a resistance RC in parallel with LM such that V_1^2/R_C= core losses. See the equivalent circuit of a real transformer shown in Fig. 2.

❸ Effect of leakage flux

A primary leakage flux links the primary winding but not the secondary; a leakage flux also exists only at the secondary. Leakage fluxes can be modeled using two inductors L_{L1} and L_{L2} as shown in Fig. 3. When we have a magnetic flux we would have leakage:

Primary Losses core Losses secondary

❹ Effect of winding resistance

The wire resistance of the windings may be accounted for by adding two resistances R1 and R2, in series with LL1 and LL2, respectively, as shown in Fig. 3. At low frequencies, these resistances are equal to their values at DC.

❺ High frequency effects

At high frequencies, the capacitance of the windings should be included in the equivalent circuit. Refer to the equivalent circuit of a real transformer shown in Fig. 3

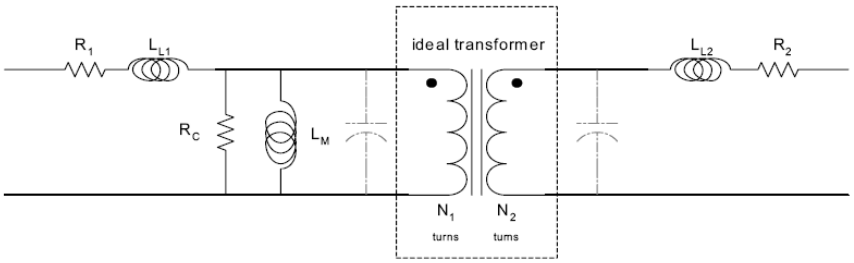

Fig. 3

❻ Notes:

We use the DMM to measure the DC resistances of the transformer primary and secondary.

❼ Using a voltage level that gives a nearly sinusoidal magnetizing current, accurately measure V_1 and V_2, and determine the turn's ratio N_1/N_2.

❽ **Increase the value of R_S to 100 Ohms. Apply a sinusoidal voltage of 100 Hz, adjusting the voltage so that the magnetizing current is nearly sinusoidal. Measure the magnitude and phase shift of this current with respect to V1.**

❾ **Connect a 100 Ohm resistor at the secondary of the transformer. Determine the bandwidth of the transformer with the load connected: find the lower cutoff frequency f_1 and the upper cutoff frequency f_2. The cutoff frequencies are the frequencies at which the output voltage is 0.7071 times its value at mid frequencies. Make sure that the magnetizing current remains sinusoidal at all frequencies.**

❿ **Using the oscilloscope, establish the polarity markings of the windings of the transformer.**

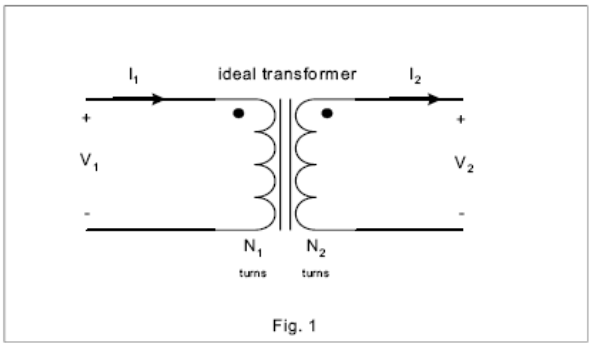

Fig. 1

Since the signals are in phase, the dots are on the same side. We insert the channels of the oscilloscope on the same sides of both transformers and we get the outputs in phase so the dot markings are on the same side.