Objectives :

- to understand the phase shift between the voltage and current for an inductor.
- to learn inductive reactance for an inductor and impedance of an AC circuit.
- to determine the inductance value L of an
- to learn how to use cathode-ray oscillosco

Equipment Used :

- coil with N = 1600 turns.
- function generator.
- variable resistance box.
- CRO with cro probe and few wires.
- two multimeters

Theory.

I) RL circuit

- The emf of the source is given by

$\mathcal{E}(t) = \mathcal{E}_m \sin \omega t = V_L$., where V_L is the voltage across the inductor.

- $\frac{di}{dt} = \frac{V_L}{L} = \frac{V_{Lm}}{L} \sin \omega t$

$\Rightarrow i_L = i_{Lm} \sin(\omega t - 90^\circ)$ where X_L is the inductive reactance of the inductor and $i_L = \frac{V_L}{X_L}$

- In RL circuit, i_L lags V_L by $\pi/2$ where i_R and V_R are in phase.

- $\mathcal{E}_m = V_{Rm} + V_{Lm} \Rightarrow \mathcal{E} = V_R + V_L$

By ohm's Law, $i^2 Z^2 = i^2 R^2 + i^2 X_L^2$

$\Rightarrow Z^2 = R^2 + X_L^2$, where Z is the impedence of the circuit.

$\Rightarrow$ By considering the internal resistance of the coil's wires, $z^2 = (R+r)^2 + X_L^2$.

- The plot of z^2 versus $(R+r)^2$ is a straight line with y-intercept $= X_L^2 \Rightarrow L = \frac{X_L}{2\pi}$

II) Cathode-ray Oscilloscope (CRO).

- A device used to visualize AC signals.

All controls are self explained and marked on the front panel.

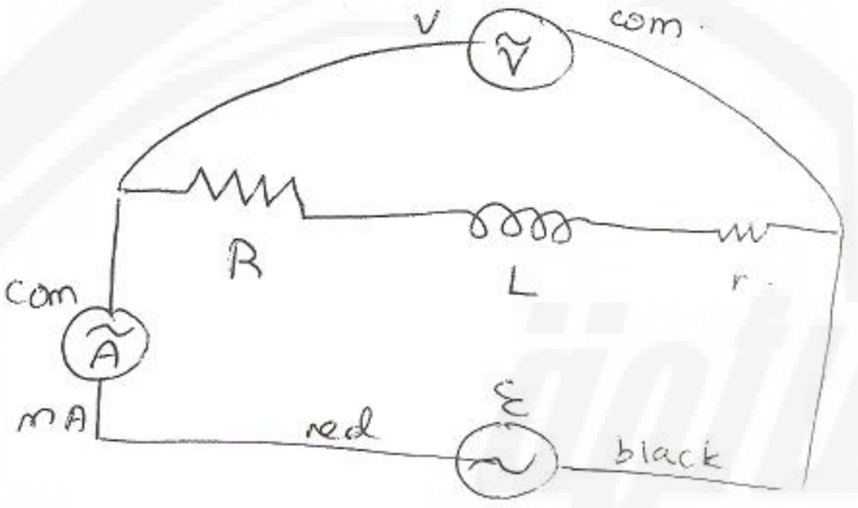
III) Root - mean - square (rms).

- $$\mathcal{E}_{rms} = \sqrt{\frac{1}{T}\int_0^T \mathcal{E}_m^2 \sin^2(\omega t)\, dt}$$

$\Rightarrow$ $$\mathcal{E}_{rms} = \frac{\mathcal{E}_m}{\sqrt{2}} = \frac{\mathcal{E}_{p-p}}{2\sqrt{2}}$$

where $\mathcal{E}_{p-p}$ is the peak to pe— volte

Diagrams



function generator

$f = 250\ Hz$

Fig (I) = connection diagram to measure V_T and I_T.

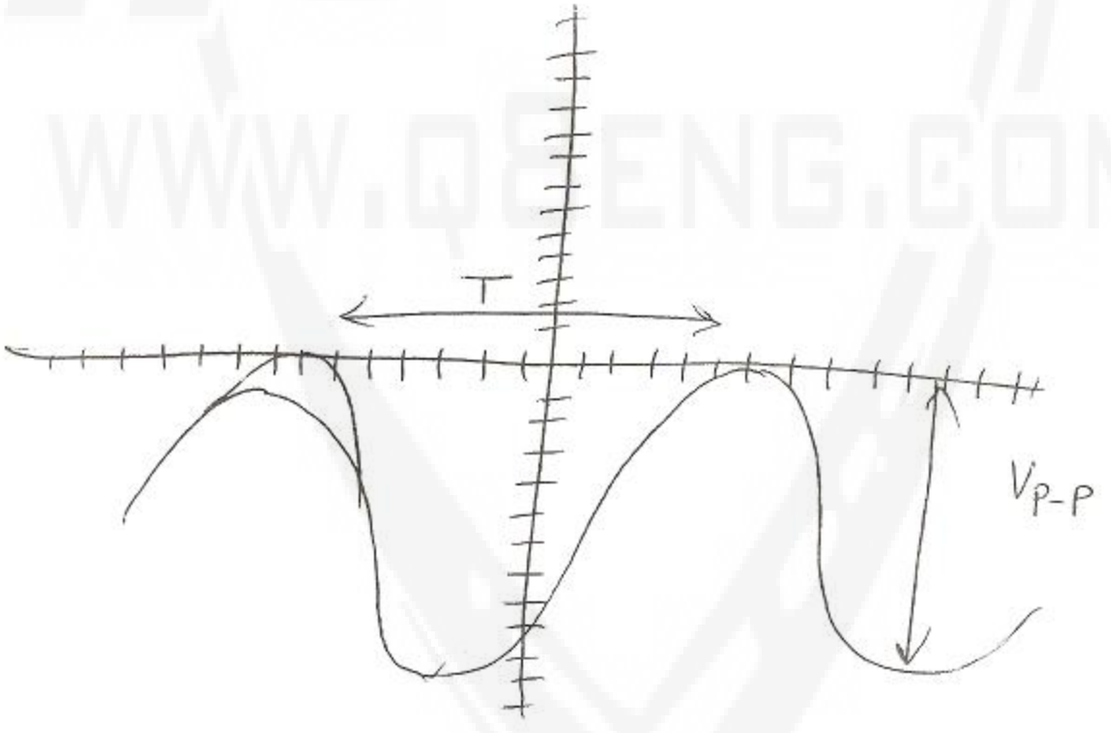


Fig (II) = AC signal on a CRO screen.

* Error sources :

* Loose connections
* Inaccuracy in taking Results.
* system errors.

procedure :

Part I : V, I measurements using multime

1- Set M.M to Ohm connect the circuit as shown in fig 1. after measuring the internal resistance of the coil.

2- Set the function generator to sine wave, frequency = 250 Hz. , and maximum amplitude.

3- Change the resistance R as in table and measure V_T and I_T through the circuit.

4- Calculate $(R+r)^2$, Z, and Z^2 for each R.

5- Plot Z^2 versus $(R+r)^2$ and use it to determine X then calculate

* Result comparison with accepted values.

- $*_L{}^2$ (from graph) = 6×10^{-3}.

$\Rightarrow$ L (from the graph) = 0.0493 H.

L (Theoritical) = 50 mH = 0.05 H.

Data tables:

R(Ω)	$(R+r)^2$ $(\Omega)^2$	I_z (A)	V_z (V)	$Z = \frac{V_z}{I}$ (Ω)	Z^2 $(\Omega)^2$
50	7.02×10^{3}	47.8×10^{-3}	5.44	113.8	12.95×10^{3}
80	12.95×10^{3}	40.7×10^{-3}	5.65	138.8	19.27×10^{3}
110	20.68×10^{3}	35.4×10^{-3}	5.87	165.8	27.49×10^{3}
140	30.21×10^{3}	31.3×10^{-3}	6.05	193.3	37.36×10^{3}
170	41.53×10^{3}	28.0×10^{-3}	6.21	221.8	49.19×10^{3}

Internal resistance of the coil = r = 33.8 Ω.

* possible Methods to avoid mistakes

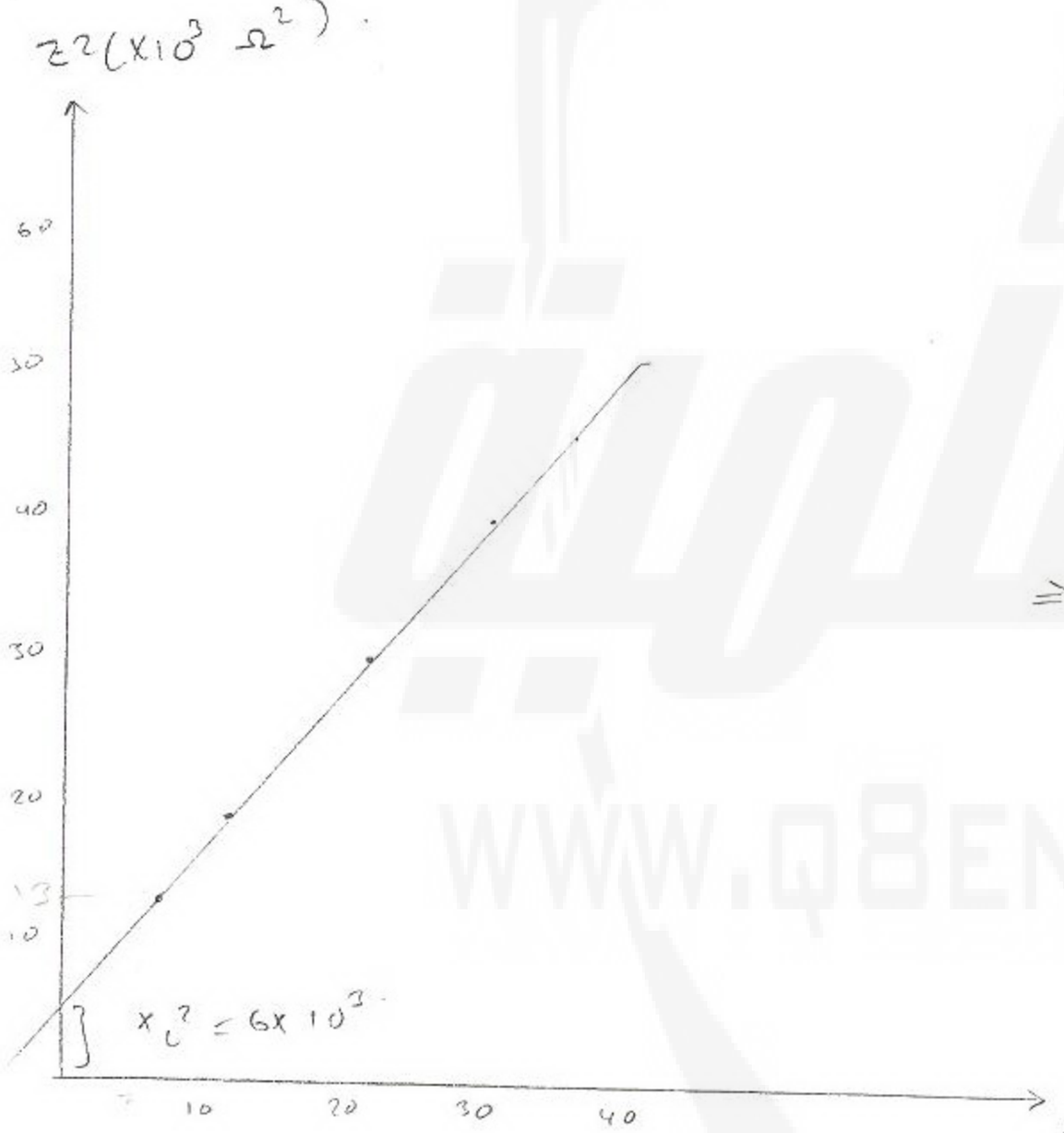
- taking reading accaurately.
- connecting the wires carefully.
- doing the calculations properly.
- test devices before using them.

* General conclusion.

- Voltage of the inductor leads the current by $\pi/2$.
- Inductors can be used as a storage element for energy.
- Internal resistance of the coil in RL circuits should be considered to get accurate values.

* Reference:

- physics university book
- physics 2 Lab Manual (107)



$$\Rightarrow \quad L = \sqrt{\frac{X_C^2}{4\pi^2 f^2}} = 0.0493\ H.$$