ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

COURSE: PHY 4242 (PHYSICS – II LAB)
EXPERIMENT NO. 5 (A)
NAME OF THE EXPERIMENT: FAMILIARIZATION WITH ALTERNATING CURRENT WAVES

OBJECTIVE:

The purpose of this experiment is to make students familiar with Alternating Current (AC) waves of various shapes. Students will learn various quantities related to AC waves and also learn how to measure them by using an oscilloscope.

INTRODUCTION:

Any periodic variation of current or voltage where the current (or voltage), when measured along any particular direction, goes positive as well as negative, is defined to be an AC quantity. The wave shapes may be of various types. The most common shapes are sinusoidal (Fig. I), triangular (Fig. II) and square (Fig. III) waves.

For sinusoidal AC waveform, the variation of current or voltage is a sine function of time.

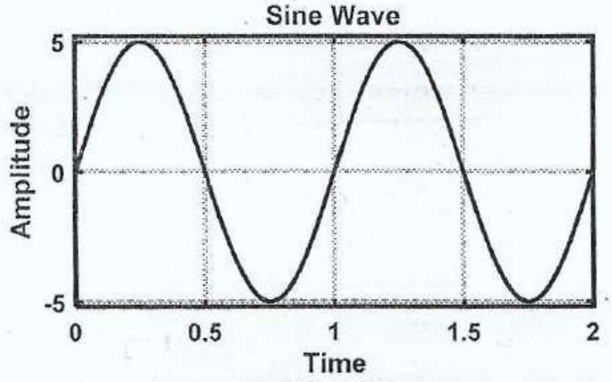


Figure I

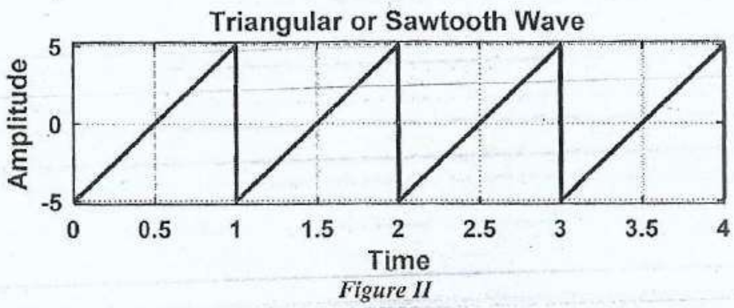


Figure II

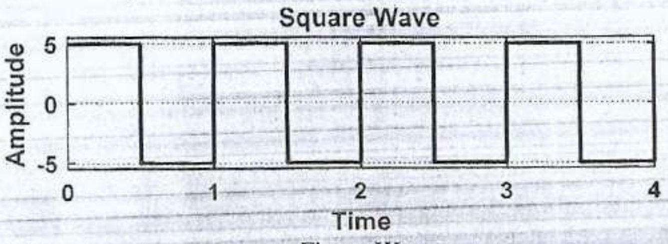


Figure III

EFFECTIVE VALUES: When we measure voltage or current by a multimeter, we actually get **effective** (Root Mean Square or **RMS**) value. **RMS** voltage is defined by

$$V = \sqrt{\frac{1}{T}\int_0^T v^2 dt}$$

The expression for current can be written in a similar fashion.

SINUSOIDAL SHAPE:

A sinusoidal variation in time is represented by the following equation.

$$v(t) = V_m \sin(2\pi f t)$$

$$\Rightarrow v(t) = V_m \sin\left(\frac{2\pi}{T} t\right)$$

Here, f is the frequency and T is the time period. Again, $v(t)$ is the instantaneous value and V_m is the maximum instantaneous value.

Again, **angular frequency,** $\omega = \frac{2\pi}{T}$.

$$\therefore v(t) = V_m sin\ \omega t$$

For sinusoidal variation, **RMS** voltage,

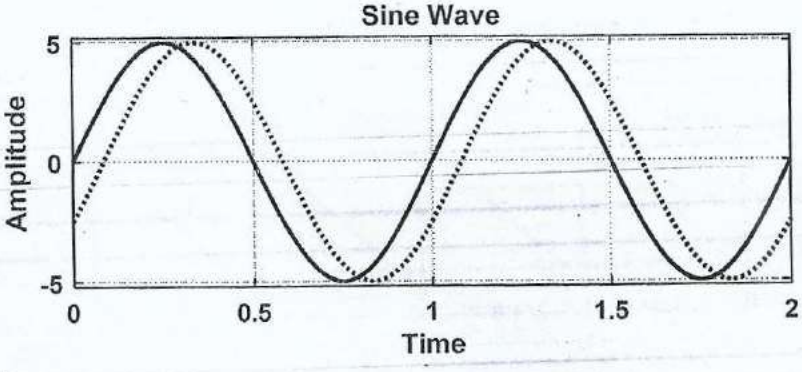
$$V = \sqrt{\frac{1}{T}\int_0^T V_m^2 \sin^2\left(\frac{2\pi}{T} t\right) dt} = \frac{V_m}{\sqrt{2}}$$

PHASE DIFFERENCE: Phase difference between two AC sinusoidal waveforms is the difference in electrical angle between two identical points of two wave shapes. Voltage equations are given by the following,

$$v_1(t) = V_m \sin\left(\frac{2\pi}{T}\right) t$$

$$v_2(t) = V_m \sin\left\{\left(\frac{2\pi}{T}\right) t - \theta\right\}$$

where the phase difference between $v_1(t)$ and $v_2(t)$ is θ.



IMPEDANCE:

The relation between a voltage across and current through any component of an AC circuit is given by impedance. It is represented by **Z.**

$$Z\angle\theta = \frac{V\angle\theta}{I\angle\theta}$$

In AC, voltage, current, and impedance all have angles associated with them.

LABORATORY TASKS:

1. Be familiar with oscilloscope and signal generator.
2. Activate the signal generator.

3. Generate various wave shapes of various frequencies. Draw them in your notebook. Measure time period (T) from the oscilloscope. Verify whether this agrees with the theoretical result.
4. Measure the peak values using an oscilloscope and calculate **RMS** value from the mathematical equations. Measure **RMS** value by the multimeter. Do they agree?

EXPERIMENT NO. 5 (B)

NAME OF THE EXPERIMENT: STUDY OF SERIES AND PARALLEL R-L-C CIRCUIT

OBJECTIVE:

i) To be familiar with AC quantities, their phase, and phase differences.

ii) As the AC quantities are vectors (Phasor), their additions, subtractions, and multiplications are in vector form. Hence, to be familiar with the drawing of vector diagrams of RLC series and parallel circuits.

THEORY:

The phase of an alternating quantity is very important to locate it properly with respect to a reference. Phase is the fractional part of a period through which time or the associated time angle ($\theta = \omega t$) has advanced from an arbitrary reference.

Fig. IV shows phase relation between the current through and voltage across resistive, purely inductive and purely capacitive elements.

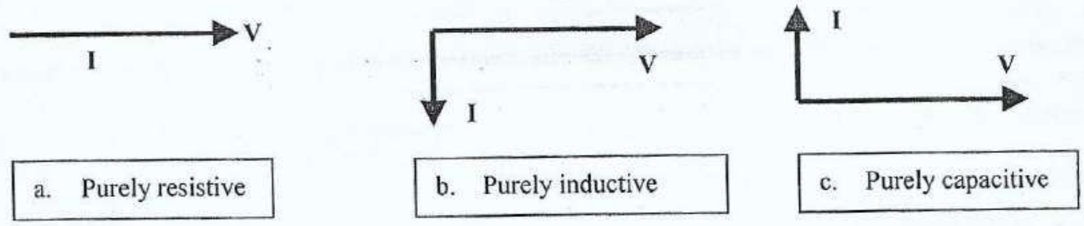


Fig. IV: Vector Diagram

In RLC series circuit, if a sinusoidal voltage is applied, then, according to KVL, the applied voltage must be equal to the vector addition of V_R, V_L, and V_C.

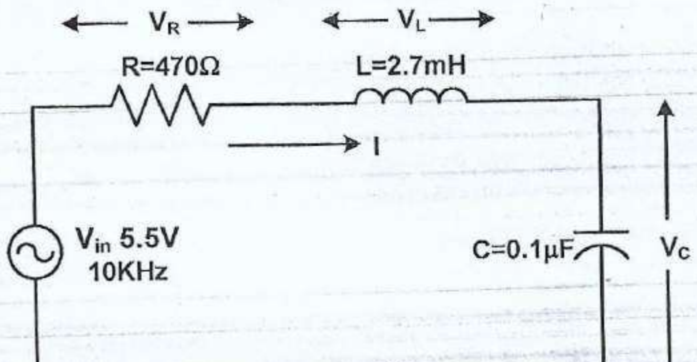


Fig: V(a)

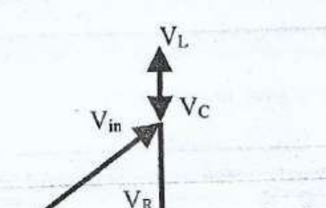


Fig: V(b)

$$V_{in} = V_R + V_L + V_C$$
$$\Rightarrow V_{in} = IR + jIX_L - jIX_C$$
$$= I\{R + j(X_L - X_C)\}$$
$$\Rightarrow \frac{V_{in}}{I} = Z = \sqrt{\{R^2 + (X_L - X_C)^2\}} \angle \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

Here, V and I indicate the RMS values, Z is the impedance.
In a series circuit, the current through the circuit is constant. Hence, to draw a vector diagram of a series circuit, it is convenient to take current as a reference. Conversely for parallel circuit voltage across parallel elements is taken as reference.

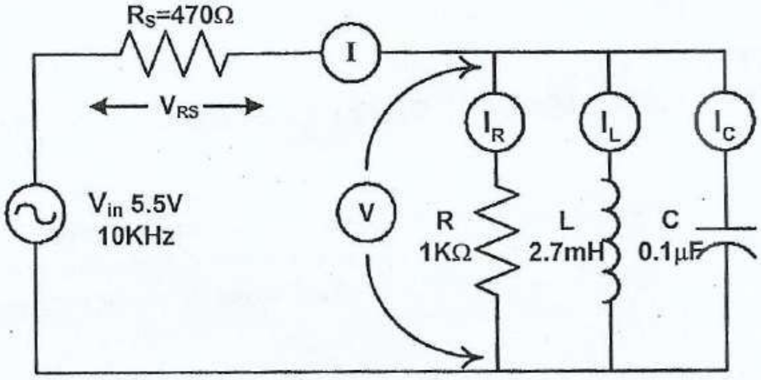


Fig: VI

APPARATUS:

- Signal generator
- Capacitor 0.1µF
- Resistors (470Ω, 1KΩ)
- Inductor 2.7mH
- Multimeter
- AC ammeter (20mA or 10mA)
- Breadboard
- Oscilloscope
- Connecting wires etc.

PROCEDURE

i. Implement the circuit of Fig. V(a) and then set the amplitude of the AC signal to maximum (V_{in} should be around 5V RMS). Take the readings of I, V_{in}, V_R, V_L, V_C using a multimeter. Observe the voltage wave shapes in the oscilloscope. Measure frequency and amplitudes of the voltages. Compare the voltage readings from multimeter and oscilloscope.

ii. Then draw a vector diagram showing all voltages and current with the help of the method shown in Fig. V(b).

iii. Similarly, connect the parallel circuit shown in Fig. VI and then set the amplitude of the AC signal to maximum (V_{in} should be around 5V RMS). Take the readings of V_{in}, V_{RS}, V, I, I_R, I_L, I_C using a multimeter. Observe the voltage wave shapes in the oscilloscope. Measure frequency and amplitudes of the voltages. Compare the voltage readings from multimeter and oscilloscope.

iv. Then draw a vector diagram showing all voltages and currents following the hint given.

DATA TABLE:

(a) For series circuit:

V_{in} (Volt)	I (mA)	V_R (Volt)	V_L (Volt)	V_C (Volt)
5.5	30	2.97	0.98	1.08

(b) For parallel circuit:

V_{in} (Volt)	V_{RS} (Volt)	V (Volt)	I (mA)	I_R (mA)	I_L (mA)	I_C (mA)
5.5	1.44	1.85	17	8.2	48	43

REPORT:

1. Show the tables and vector diagrams.
2. Discuss on the obtained results and discrepancies (if any).