The Hashemite University

Faculty of Engineering

Department of Electrical Engineering

Electrical Circuit Lab

Experiment “7 “(Basic AC Laws)

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- Objectives:

- To introduce time varying and periodic signals.
- To investigate the voltage-current relationship, and its dependence on frequency for resistors and inductors.
- To implement Ohm's law, KVL and KCL for AC circuits.

- Theoretical:

The Voltage-Current Characteristic of a Resistor

For a resistor, the relation between current and voltage is linear. It is given by Ohm's law:

$$v(t)=R.i(t)$$

This relation doesnot change for the sinusoidal signal or any other signal. Therefore the Ohm's law can be expressed in the phasorform as following:

$$V= R\ I \quad Vm\angle\theta = RIm\angle\theta$$

Clearly the voltage amplitude is merely the current amplitude multiplied by the constant R. A resistor does notintroduce phase shift between the voltage across and the current through it. Furthermore the above relationships are independentof the frequency of the sinusoidal signal.

The Voltage-Current Characteristic of an Inductor

For an inductor, the relation between current and voltage is:

$$V(t)=L\frac{d}{dt}i(t)$$

This relation does not change for the sinusoidal signal or any other signal. For sinusoidal signals, the phasor form is given by:

$$V = Lj\varpi I$$

The voltage amplitude is the current amplitude multiplied by the constant L and the radian frequency ω. Therefore, the voltage amplitude is directlyrelated to the frequency. In addition, the current lagsthe voltage by an angle of 90 degree.

Applaying KVL and

KVL and KCL are applicable to AC signals the same way they are for DC signals:a-KVL: the algebraic sum of the voltages around any closed path in a circuit is zero.

$$\sum_{=N} vi=0$$

Where N is the number of drop voltages around any closed loop.b-KCL: the algebraic sum of the currents around entering any node is zero.

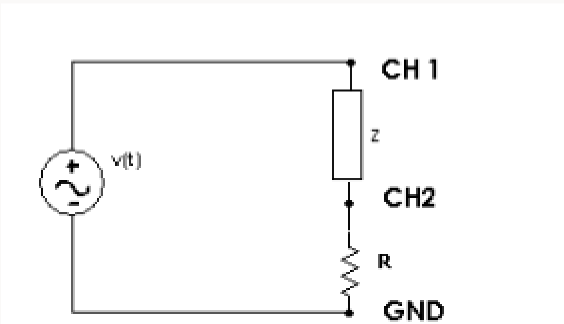
$$\sum_{N} Ii=0$$

Where N is the number of entering currents through any node.

Measuring Current with CRO

To study the voltage-current characteristic of any component Z, it is necessary to observe both the voltage across and the current through this component. Since CROs display voltage only, an indirect method must be used to display current.By placing a resistor R in series with the component Z(see figure7.1)the voltage drop across the resistor will be directly related to the current in Z,

and this voltage can be observed on the CRO. By dividing the value of this voltage by the resistance value of R, we get a measure of the current in Z. The resistor R must be small to limit the voltage across it, and its power rating should be considered carefully to sustain the current in the circuit.

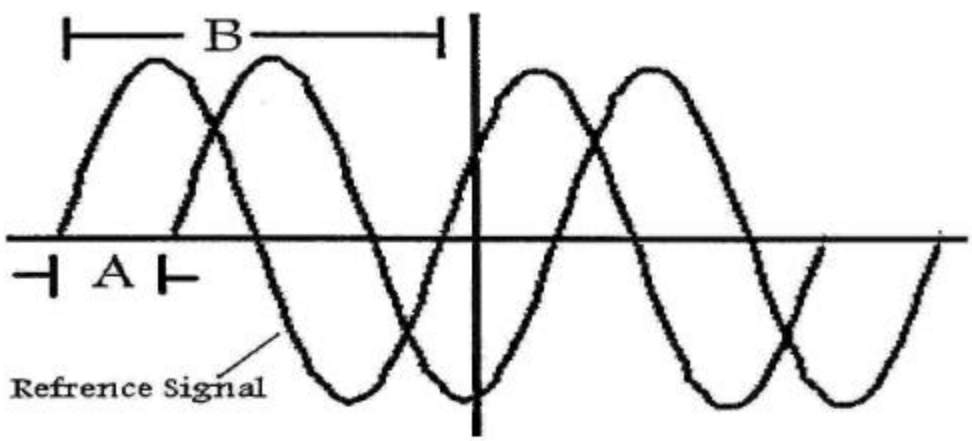


Measuring Phase Shift with CRO

measure the phase shift between two signals (with the same shape and the same frequency. Observe the following procedure:

1.Connect the two signals to the two channels of the CRO. They must both have the same ground level.
2.Choose one of the signals as the reference.
3.Measure the number of horizontal divisions for one full cycle of the reference signal (the distance B).
4.Measure the number of horizontal divisions between two corresponding points of the wave forms (the distance A).
5.The phase shift is given by the formula:

$$\theta = \frac{A}{B} \times 360^o \text{ [in degrees]} \quad \text{or} \quad \theta = 2\pi f \times (\text{time/div}) \times A \text{ [in radians]}$$

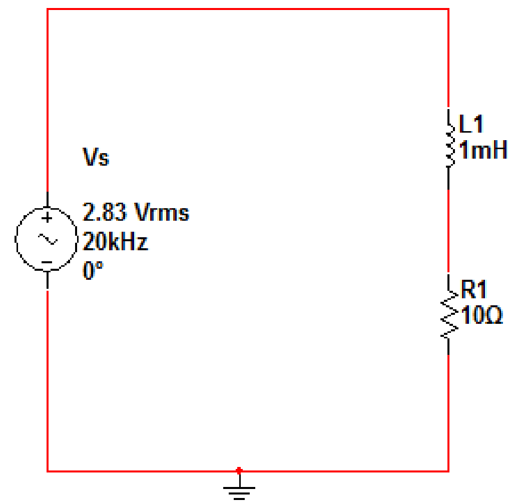


- **Equipment:**

FG, CRO, DMM, and various components.

- Procedure:

RL Circuit



V_L Lag with I_L

1- Find the magnitude of V_L , V_R and I_L ?

2- Find the phase shift between V_s and I_s ?

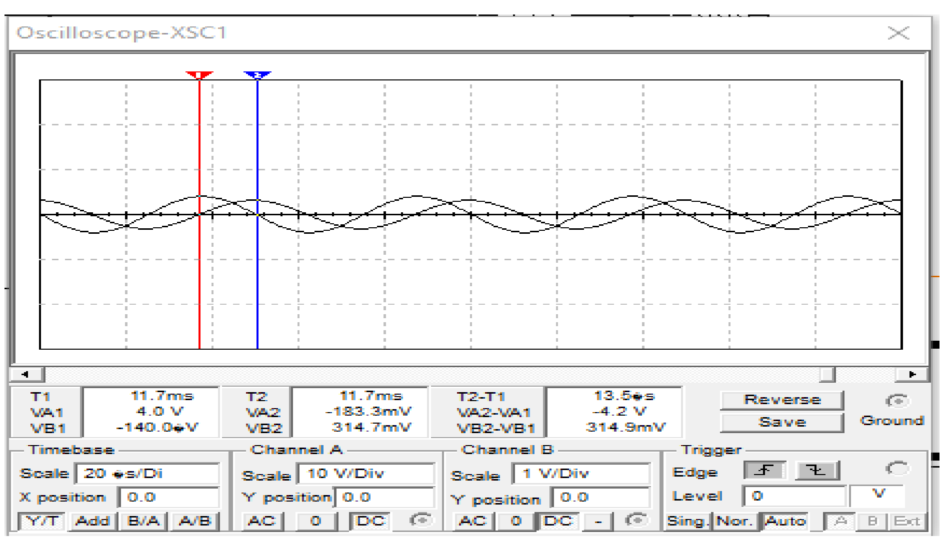
3- Plot V_s and I_s on the same graph ?

F=20kHZ , $\Delta t = 12micro, \quad \theta = \Delta t.F.360 = 86.3degree$

Vrms=2040mV, Irms=Vrms/R =20.4mA, w=2πF , w =125.6k

ZL=jWL → ZL=125.6j   Zeq=10+125.6j

$IL = \frac{Vrms}{zeq} = \frac{2.83\angle 0}{10+125.6j}$ =0.022$\angle -85.4$ V=I.Z → $VR = 0.22\angle -85.4 \quad VL = 2.8\angle 4.55$



- Conclusion:

Design circuit consist of Rossiter and inductance .

Calculate current, voltage and impedance by Complex equations (phase shift).

To know the phase of current will lag voltage in INDUCTANCE circuits and angle with inductance without Rossiter to 90 degree.

phase in several cases in AC circuits, phase of current will vary of voltage phase.