KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

Electrical Engineering Department

EE 208 ELECTRICAL SYSTEMS

Experiment # 8 OSCILLOSCOPE AND AC CIRCUITS

OBJECTIVE:

1. To study a **function generator** and an **oscilloscope**.
2. **Experimentally** measure the **amplitude,** the **frequency** and the **phase** difference between **two** sinusoidal signals.
3. To experimentally **verify frequency domain calculations**.

APPARATUS: Function Generator & Oscilloscope
Ohmmeter, AC Voltmeter and AC Ammeter
Capacitor 0.022 μF & Inductor 8.2 mH
Resistor: 100 Ω, 1 KΩ (Two), and 1.5 KΩ.

Part I: Function Generator and Oscilloscope

The Function Generator: This is also known as a **signal generator** or **oscillator**. It is used as a voltage source to **produce** a sinusoidal, a square, a triangular and other **periodic waveforms**. The **frequency** of the wave can be changed over a wide range. The wave **amplitude** can also be varied.

The Oscilloscope: The oscilloscope is a device that takes an electrical signal v(t) at its input and **displays a trace of this signal on a screen**. The **vertical** deflection of the trace is proportional to the input signal **voltage**. The **horizontal** deflection of the trace is proportional to **time**. Hence, the trace observed on the screen gives the time history of the input signal **[i.e. v(t) versus t].** The oscilloscope has **two channels**, channel **A** and channel **B**, **each** of which can be used to display the trace of an input signal. **Both** channels can be used to see the **trace** of two input signals **simultaneously**. This is useful for the purpose of comparing two input signals.

PROCEDURE:

1. **Connect** the circuit shown in Figure 1.
2. **Turn** the oscilloscope **ON**.
3. **Connect** channel **A** of the oscilloscope across the **function generator** [i.e. across V_S (t)] and set the **Volt/Div** of channel A to **2 V/Div**. **Channel A** is thus used to display a **trace of V_S(t).**
4. **Connect** channel **B** of the oscilloscope **across R_2** and set the **Volt/Div** of channel B to **2 V/div**. Channel **B** is thus used to display a **trace of V_2(t).**
5. Set the **time/Div** to **0.2 ms** for each channel.
6. For **each** channel, set the **ground** level to the **middle** of the screen.

7. **Turn** the function **generator ON** and select the **sinusoidal** option.
8. **Adjust** the **amplitude** until $V_S(t)$ reaches **16 V** peak to peak. *(How many vertical divisions are required?* See Step 3.
9. **Adjust** the **frequency** of $V_S(t)$ until you obtain **2000 Hz.** *(How many horizontal divisions are required for each period?* see Step 5.
10. Select channel **B** to observe the trace representing **V_2(t)** and **answer the following questions** (write the answers in Table 2):
    a) What type of wave do you get?
    b) What is the amplitude (peak to peak) of $V_2(t)$?
    c) Does the amplitude of $V_2(t)$ satisfy the theoretical prediction using Ohm's Law?
    d) What is the period of $V_2(t)$? Is it the same as the period of $V_S(t)$?
11. **Display both** channels and **plot** the oscilloscope trace of both **signals** on the same graph.

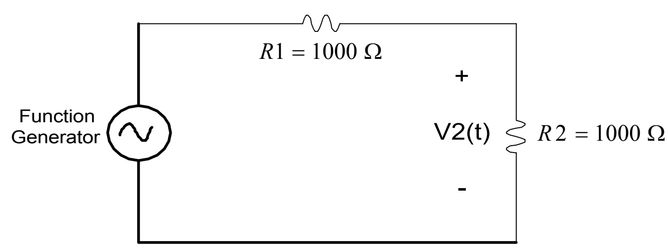

Figure 1

Part II: Frequency Domain Analysis using phasor method

In the frequency domain (phasor domain), the currents and voltages are represented by **complex numbers** whose **magnitudes** are equal to the maximum values of the sinusoidal time-domain quantities, and whose **angles** are equal to the phase angles of the time-domain functions expressed as cosines.

In terms of voltage and current phasors and the complex impedance $\bar{Z}$, Ohm's law becomes:

$$\bar{V} = \bar{I}\,\bar{Z} \qquad (1)$$

Where $\bar{Z}$ = R for a resistance, $\bar{Z}$ = jωL for an inductance & $\bar{Z} = \frac{1}{j\omega C}$ for a capacitance.

And $\omega = 2\pi f$ is the **angular frequency** of the voltage source. **The bar indicates a complex quantity.**

In general, for $\bar{V} = V\angle\alpha$ and $\bar{I} = I\angle\beta$, the impedance $\bar{Z} = \frac{V}{I}\angle\alpha - \beta$

Analytically, frequency-domain circuits are treated by the same method as used in D.C circuits, except that the algebra of complex numbers is used.

Experimentally, the frequency-domain phasors can be measured on the oscilloscope. The **magnitudes** can be measured by means of calibrated vertical scales. **Phase** difference can be measured by using the **dual traces** and measuring the time difference between two waveforms, as illustrated in Figure 2.

IMPOTANT NOTE: When measuring the phase difference between two signals, make sure that **the control knobs in the oscilloscope** are set properly such that the signals are not relatively inverted.

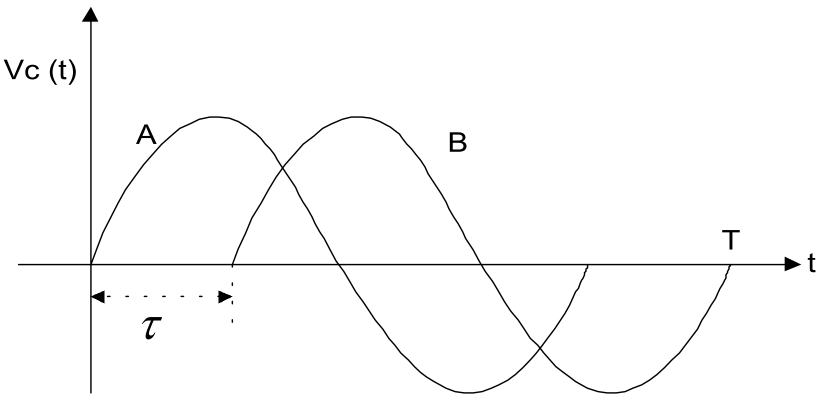

Figure 2

Time shift = τ

Phase shift = 360 $(\frac{\tau}{T})$ degrees

Signal B lags signal A.

PROCEDURE:

1- **Measure** the resistor values and **the internal resistance** of the inductor, using an Ohmmeter.

2- **Connect** the circuit of **Figure 3**. **Adjust** the source voltage to **10 V peak** at **20 kHz,** while it is connected to the circuit.

3- Use **the oscilloscope** to measure the **magnitudes** and **phases** of the voltages $\overline{V}_1, \overline{V}_2, \text{and}\ \overline{V}_4$ with reference to the source voltage. Record your measurements in Table 3.

4- **Find** $\bar{I}_1$ **from** $\bar{V}_1$**. Find** $\bar{I}_2$**,** from the measurement of voltage across **the 100 Ω** resistor in series with the capacitor. Record your results in Table 3.

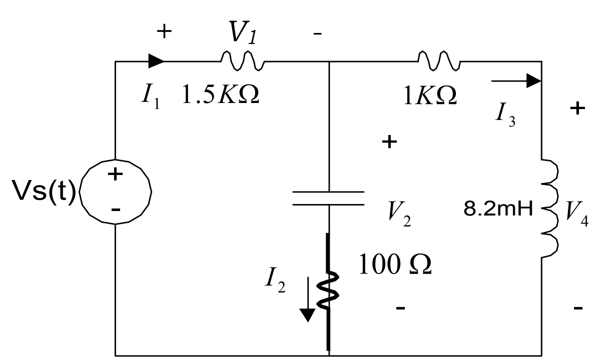

Figure 3

IMPORTANT NOTE: Whenever two signals are to be displayed simultaneously on the oscilloscope, **they should have one common node as a reference.**

Therefore, you may have to change the position of some elements to be able to measure two signals simultaneously.

REPORT:

1- **Using Pspice,** draw the circuit given in Figure 3 in the **Schismatic**.
2- Inter the values & names of each element and choose in the **setup AC analysis**.
3- Run the program and find the variables indicated in the circuit of Figure 3.
4- Summarize your results in Table 3.
5- Write down the time functions (instantaneous representation) for the voltages and currents in Table 4.

EXPERIMENT # 8 Laboratory Report

Name: .... **I.D.** .... **Lab. Section:** ....

TABLE 1

Resistor Values:

Resistor	R_1	R_2	R_3	R_4	R_L	L	C
Nominal Value (Ω)	100	1k	1.5k	100	56Ω	8.2 mH	0.022 μF
Ohmmeter reading							

TABLE 2

Part I: Function Generator

V_2 (t) type of wave	
Amplitude (peak to peak) of V_2 as read from the oscilloscope	
Amplitude (peak to peak) of V_2 as predicted by Ohm's law	
Are the above tow values of amplitude the same?	
Period of V_2 (t)	
Are the periods of V_2 (t) and the V_s (t) the same	

Part II: Frequency Domain Analysis using phasor method

Internal resistance of the inductor =

TABLE 3

		V_1	V_2	V_4	I_1	I_2
Experimental Values	**Magnitude** (Volts)					
	Phase Shift (Degrees)					
Simulated Values	**Magnitude** (Volts)					
	Phase Shift (Degree)					
% Error	**Magnitude**					
	Phase Shift					

TABLE 4

Time Function of Theoretical and Experimental Voltages and Currents:

	Theoretical	Experimental
$V_1(t)$		
$V_2(t)$		
$V_4(t)$		
$I_1(t)$		
$I_2(t)$		