Name: Lab section: Lab Sheet (14 marks): ________________

Report Sheet (16 marks): ________________

# Lab 2: AC Phasors

## INTRODUCTION:

In this lab, you will apply your knowledge on phasor techniques to analyze some basic circuits comprising resistors and reactive components (i.e. capacitors). The objective here is to relate a theoretical understanding of impedance and phase to what can be observed using an oscilloscope. In the process, you will learn how to use a signal generator to output a sinusoid signal and an oscilloscope to measure them.

**Learning outcomes**

- ☐ Demonstrate use of a signal generator to output AC signals and an oscilloscope to measure them
- ☐ Explain from observation the dependence of impedance on the AC signal frequency
- ☐ Observe the superposition of multiple frequency sources in a basic circuit with reactive components
- ☐ Appreciate that coaxial cables have capacitances and explain their effects on AC signals

## REQUIRED MATERIALS:

Hardware:

1) Digital multimeter (DMM)
2) Cathode ray oscilloscope (CRO)
3) Signal generator

Components:

1) Set of resistors
2) 1 capacitor (68nF); 1 inductor (10mH)
3) Breadboard

## Lab Task 1: Applying phasor techniques using single source

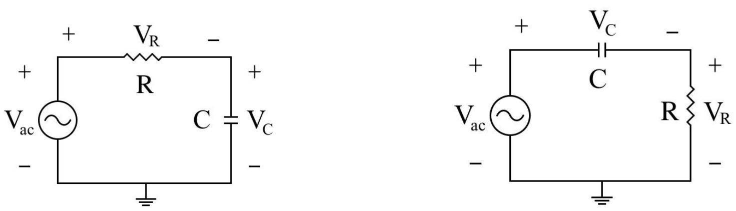


Fig 1a (left) & Fig 1b (right): Schematic of an RC circuit

1.1 Assemble the circuit of Fig. 1 on a breadboard, given $V_S = 5\cos(2\pi f\,t)$ V, R = 1.2 kΩ, C = 68 nF. Use the signal generator to apply the AC signal ($V_{ac}$), setting the frequency to 2.5kHz. Tune the amplitude of the sine wave until it reaches 5V (i.e. value used in pre-lab 1).

1.2 Using the oscilloscope, measure $V_C$ (using Fig 1a) and $V_R$ (using Fig 1b) at 2.5kHz. To measure phase, the wave form of Vs should also be monitored on the oscilloscope when you measure $V_C$ and $V_R$.

1.3 Then set the frequency of the signal generator to 5kHz and measure $V_C$ and $V_R$ again.

Table 2: Measured values for Task 1

| | **Measured $V_C$ (Fig 1a)** | | **Measured $V_R$ (Fig 1b)** | | **I (Calculate using $V_R$)** | |
|---|---|---|---|---|---|---|
| | **Amplitude** | **Phase** | **Amplitude** | **Phase** | **Amplitude** | **Phase** |
| **@ 2.5kHz** | | | | | | |
| **@ 5kHz** | | | | | | |

**Make sure you are graded for Lab Task 1 before moving on to Lab Task 2** _______ **/ 6 marks**

Check Point 1: Lab Demonstration to Supervisor

## Lab Task 2: Dual source

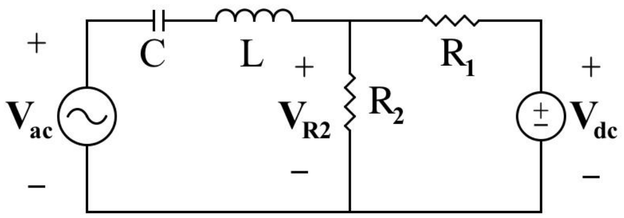


Fig 2: Schematic of circuit with two input sources with different frequencies

2.1 Assemble the circuit you have analyzed in Fig. 2 on a breadboard, giving $R_1$ = 1.5 kΩ, $R_2$ = 1 kΩ, L = 10 mH, C = 68 nF, $V_{ac} = 5\cos(2\pi ft)$ V, and $V_{dc}$ = 3V. This should only require a small modification of the circuit. Use the power supply to apply a DC voltage of $V_{dc}$ = 3V.

2.2 Keep the amplitude of the AC signal at 5V (same as Lab Task 1) and set the frequency to 2.5 kHz.

2.3 Measure $V_{R2}$. Observe the waveform of $V_{R2}$ in both AC mode and DC mode. You should notice two frequency components on the oscillator. The DC component is more distinguishable when you change the oscilloscope setting from AC mode to DC mode. Ask a lab staff to show you how to switch between AC and DC mode on the oscilloscope if you are unsure.

2.4 Obtain the two waveforms of $V_{ac}$ and $V_{R2}$ (in DC mode). Identify the various frequency components on your graph. Note down the amplitude of the AC wave from $V_{R2}$ and its phase relative to $V_{ac}$. You should draw or capture all the waveforms.

2.5 Demonstrate step (4) to the lab supervisor / demonstrators / technical staff and fill in the blank spaces below (in phasor form).

2.6 Then adjust the signal generator frequency to 5 kHz and measure $V_{R2}$ again.

At 2.5 kHz, $V_{R2}$ = __________ (DC component) + _______________ (AC component)

At 5 kHz, $V_{R2}$ = __________ (DC component) + _______________ (AC component)

Check Point 2: Lab Demonstration to Supervisor

_______/ **8 marks**

**Make sure you are graded for Lab Task 2 before leaving.**

**Remember to complete the Lab Report Sheet.**