ECE 541: Electric Circuits

Laboratory Exercise #3: Introduction to AC Signals

Weeks of 10/24/22 (Group A) and 10/31/22 (Group B)

Name: Nick Snyder Date: 10/24/22

1. Introduction

In this laboratory exercise, AC signals and their measurements will be introduced. The objective of this lab is to become familiar with a signal (waveform) generator and an oscilloscope. Signal generators are capable of producing AC waveforms that are a function of amplitude, time, and frequency. The oscilloscope can display and enable measurement of voltage waveforms. Students will use both the digital multi-meter (DMM) and the oscilloscope to measure peak amplitude and RMS voltages at different points in a resistor network. The concepts of node-voltage and mesh-current equations will be applied to the test circuits.

2. Procedure

2.1. Node-Voltage Measurement

- Set up the circuit shown in Figure 1.
- Adjust the signal generator to produce a 1 V amplitude sinusoid at 1 kHz.
- Using the oscilloscope, measure the amplitude and frequency of the input waveform at node V_1 and confirm that the waveform generator is adjusted properly.
- Using the oscilloscope, measure the peak voltages at node V_2 and V_3 (relative to GND).

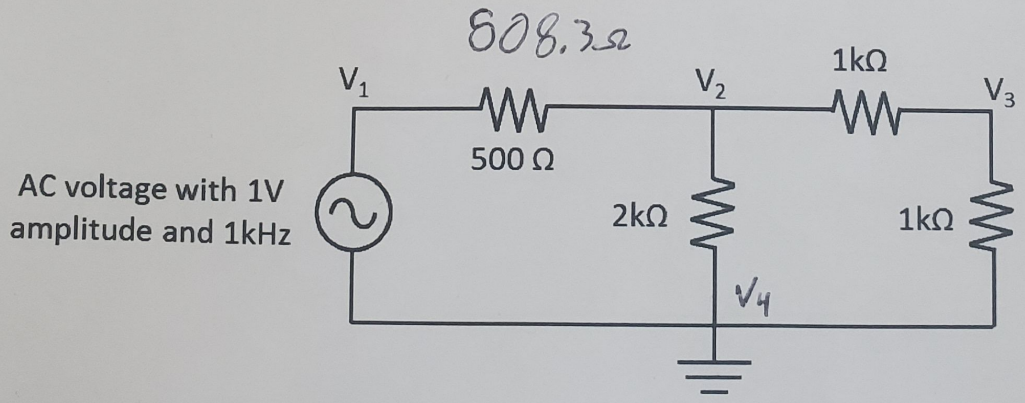

Figure 1: Resistive Circuit with Sinusoidal Waveform Input

- Record the measurements below:

$V_{1,peak}$: 1 V $V_{2,peak}$: 0.64 V $V_{3,peak}$: 0.330 V

- Using the DMM measure the RMS (Root Mean Square) voltage at nodes V_1, V_2, and V_3 (Relative to GND).

$V_{1,RMS}$: ~~66.79mV~~ 0.87 $V_{2,RMS}$: 44.24 mV $V_{3,RMS}$: 22.11 mV

- Calculate the RMS voltages at nodes V_1, V_2, and V_3 using the amplitudes V_1, V_2, and V_3. Note: For a sinusoidal waveform, $V_{RMS} = \frac{V_{peak}}{\sqrt{2}}$

$\frac{1}{\sqrt{2}}$ $\frac{0.64}{\sqrt{2}}$ $\frac{0.33}{\sqrt{2}}$

$V_{1,RMS}$: 0.707 V $V_{2,RMS}$: 0.453 V $V_{3,RMS}$: 0.233 V

- Do the calculated RMS voltages match the DMM-measured RMS voltages?

They are close but not exact

- Measure the frequency of the waveforms at nodes V_1, V_2, and V_3.
Note: This should be done both with the DMM and from the waveform period measured on the oscilloscope.

Freq@V_1: 1,006 Hz Freq@V_2: 1006 Hz Freq@V_3: 1006 Hz

- Using the node-voltage equations, calculate the RMS voltages at nodes V_1, V_2, and V_3.

$$\frac{V_1 - V_4}{\sqrt{2}} = \frac{1}{\sqrt{2}} \qquad \frac{V_2 - V_4}{\sqrt{2}} = \frac{0.64}{\sqrt{2}} \qquad \frac{V_3 - V_4}{\sqrt{2}} = \frac{0.33}{\sqrt{2}}$$

$V_{1,\,RMS}$: 0.707 $V_{2,\,RMS}$: 0.453 $V_{3,\,RMS}$: 0.233

- Do the node voltages calculated using the node-voltage technique equal the measured node voltages?

Same

- Using the invert and add functions of the oscilloscope, measure the voltage between nodes V_2 and V_3, that is $(V_2 - V_3)$.

$(V_2 - V_3)_{peak}$: 1.22V $(V_2 - V_3)_{RMS}$: 386mV

- Using the DMM, measure the RMS voltage of $(V_2 - V_3)$.

$(V_2 - V_3)_{RMS}$: 36.83mV

- Does the voltage $(V_2 - V_3)_{RMS}$ calculated from the oscilloscope measurements match the voltage measured with the DMM?

no

- Check your answers in section 2.1 with the TA.

TA's Signature: