INTRODUCTION

In this exercise we will investigate some of the frequency response characteristics of circuits containing resistive, inductive and/or capacitive elements by performing a phasor analysis of those circuits at a variety of frequency values.

NOTES

- This exercise is to be completed on an **individual basis**. No collaboration is allowed between students during the completion of this exercise. If questions arise, contact your instructor for help.
- Utilize **Excel** to perform the calculations and to create the plots required for this experiment.
- Maintain at least three (3) significant digits of accuracy in all of your calculations.

Reminder – When performing a phasor analysis of the circuits defined for this experiment, be sure to express all voltages and currents in terms of their (RMS) phasor equivalents and all resistive, inductive, and capacitive load values as impedances.

PROCEDURE

Investigation # 1 – Frequency Response of R-L, R-C, and R-L-C Circuits

Note – Use the following component values for all the circuits utilized during this experiment:
(I.e. – for the circuits shown in Figures 8.1, 8.2, and 8.3)

$$v(t) = \sqrt{2} \cdot 24 \cdot \sin(\omega t + 0°) \text{ volts}, \quad R = 62\Omega, \quad L = 5mH, \quad C = 0.42\mu F$$

Series R-L Circuit Response

1. Given the circuit in shown in **Figure 8.1**, utilize **Excel** to perform a **phasor analysis** of the circuit as the frequency (f) varies from **0Hz → 20000Hz** in **250Hz steps**.

   At each frequency, **determine** the (RMS) <u>**magnitudes**</u> of the **current** $\tilde{I}_1$, the **inductor voltage** $\tilde{V}_{L1}$, the **resistor voltage** $\tilde{V}_{R1}$, and the **real power** P_{R1} supplied to the resistor.
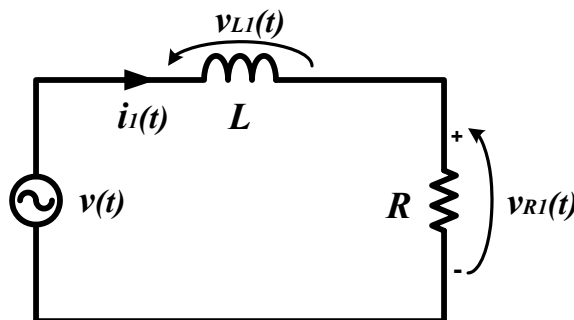

Figure 8.1 – AC Response of an R-L Circuit

Hints – although Excel is able to perform complex number calculations, you are only being asked to determine the **magnitudes** of the voltages and current. Thus, it may be easier to complete this experiment by defining a set of circuit equations based only on magnitudes.

– to avoid a "divide-by-zero" error in Excel, approximate the solution for the voltages and currents at 0Hz by utilizing a very tiny frequency, such as 0.001Hz, instead of 0Hz in your spreadsheet.

2. **Compile** ("tabulate") the results of your analysis into a table that has the following <u>format</u>:

Frequency (Hz)	Current I_1 (A)	Inductor Voltage V_{L1} (V)	Resistor Voltage V_{R1} (V)	Resistor Power P_{R1} (W)
0				
250				
500				
↓				

such that it displays the ***current and voltage magnitudes*** along with the ***resistor powers*** at each frequency step.

*Be sure that the table is titled appropriately (**Table 8.1 – AC Analysis of an R-L Circuit**) and that the appropriate units are displayed in the column headings of your table. The same should hold true for the tables required for the remaining steps of this experiment.*

3. On one graph, **plot** the ***magnitude*** of the **current** *as a function of frequency*.
    (I.e. – the vertical axis is current and the horizontal axis is frequency)

    Be sure that all of your plots have accurate titles, that their axes are all labeled, and that the appropriate units are shown.

4. On a separate graph, plot **both** the ***magnitude*** of the **resistor voltage** and the ***magnitude*** of the **inductor voltage** *as a function of frequency*.
    (Note – both voltages must be plotted on the <u>same</u> graph.)

5. On a third graph, plot the **resistor power** *as a function of frequency*.

6. Provide an **analysis** of your results <u>as represented by the data shown on your plots</u>.

    Include a discussion on the "real world" or practical aspects of this circuit.

    Note - It may be useful to think in terms of the resistor being the "load" to which the voltage source is supplying real power, and the inductor as a "device" placed in between the "source" and the "load" that affects how much of the "source" waveform that the "load" resistor actually receives.

<u>**Series R-C Circuit Response**</u>

7. Given the circuit in shown in **Figure 8.2**, utilize **Excel** to perform a **phasor analysis** of the circuit as the frequency (f) varies from **0Hz → 20000Hz** in **250Hz steps**.

    At each frequency, **determine** the (RMS) <u>**magnitudes**</u> of the **current** $\tilde{I}_2$, the **capacitor voltage** $\tilde{V}_{C2}$, the **resistor voltage** $\tilde{V}_{R2}$, and the **real power** P_{R2} supplied to the resistor.
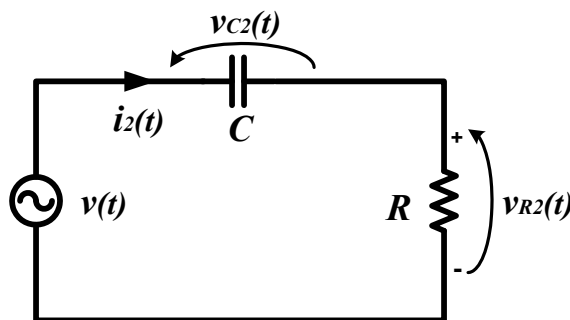

Figure 7.2 – AC Response of an R-C Circuit

8. **Tabulate** the results in a **new table** that displays the *current and voltage magnitudes* along with the *resistor powers* at each frequency step.

9. On one graph, **plot** the *magnitude* of the **current** *as a function of frequency*.

10. On a separate graph, plot **both** the *magnitude* of the **resistor voltage** and the *magnitude* of the **capacitor voltage** *as a function of frequency*.

11. On a third graph, plot the **resistor power** *as a function of frequency*.

12. Provide an **analysis** of your results, as represented by the data shown on your plots.

    Include a discussion on the "real world" or practical aspects of this circuit.

Series R-L-C Circuit Response

13. Given the circuit in shown in **Figure 8.3**, utilize **Excel** to perform a **phasor analysis** of the circuit as the frequency (f) varies from **0Hz → 20000Hz** in **250Hz steps**.

    At each frequency, **determine** the (RMS) <u>**magnitudes**</u> of the **current** $\tilde{I}_3$, the **resistor voltage** $\tilde{V}_{R3}$, the **inductor voltage** $\tilde{V}_{L3}$, the **capacitor voltage** $\tilde{V}_{C3}$, and the **real power** P_{R3} supplied to the resistor.
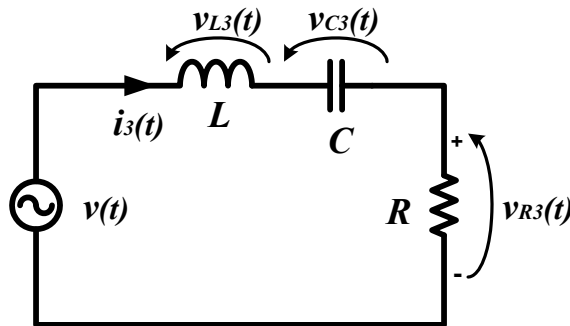

Figure 7.3 – AC Response of an R-L-C Circuit

14. **Tabulate** the results in a **new table** that displays the *current and voltage magnitudes* along with the *resistor powers* at each frequency step.

15. On one graph, **plot** the *magnitude* of the **current** *as a function of frequency*.

16. On a separate graph, plot the *magnitudes* of the **resistor**, **inductor and capacitor voltages** *as a function of frequency*.

17. On a third graph, plot the **resistor power** *as a function of frequency*.

18. Provide an **analysis** of your results, as represented by the data shown on your plots.

    Include a discussion on the "real world" or practical aspects of this circuit.

REPORT GUIDE – DUE BY 11:30AM ON MONDAY, AUGUST 1ST

For this experiment, you are required to submit (in the following order):

1) A **cover sheet** containing your name, your lab section, and the submission date,

2) A **printout** of the (Excel) **results table for the R-L circuit**,

3) A **printout** of the required **plots for the R-L circuit**,

4) An **analysis** of the **R-L results**. (See procedure step 6 for more information)

5) A **printout** of the (Excel) **results table for the R-C circuit**,

6) A **printout** of the required **plots for the R-C circuit**,

7) An **analysis** of the **R-C results**.

8) A **printout** of the (Excel) **results table for the R-L-C circuit**,

9) A **printout** of the required **plots for the R-L-C circuit**,

10) An **analysis** of the **R-L-C results**.

Note –Since your Excel tables will most likely span across several pages, you do not need the entire Excel tables… the top 8 rows of each table (including headers) will suffice.