American International University- Bangladesh
Department of Electrical and Electronic Engineering
COE 2102: Introduction to Electrical Circuits Laboratory

Title: Study of 'Nodal Analysis' in *R-L-C* combination circuit in AC

Abstract:

The purpose of this experiment is to develop an understand the method of determining voltage and current using 'Nodal Analysis' in a *R-L-C* AC circuit. The circuits containing *R*, *L* and *C* components and is to be able to analyze the outputs of *R-L-C* series-parallel combination circuit to obtain practical value as well as simulated or theoretical results. Moreover, the determination of phase relationship between V and I in an R-L-C combination circuit and to draw the complete vector diagram will be done to understand the method of using Nodal analysis.

Theory and Methodology:

Nodal analysis is used for solving any electrical network, and it is defined as the mathematical method for calculating the voltage distribution between the circuit nodes. This method is also known as the node-voltage method since the node voltages are with respect to the ground. This laboratory experiment explores the techniques to solve AC circuits using node-voltage. In this section, we are going to experimentally measure the Node voltage of an AC circuit that has been calculated and simulated using the node-voltage method.

Nodal analysis is a widely used method to solve AC electric circuits. This method is useful when circuits contain more than one source or any complex combination system. The AC Node-voltage method, like the DC node-voltage method, is based on Kirchhoff's current law around each node. Once all the independent equations are obtained, they are solved simultaneously for each node. The rules for setting up and performing AC node-voltage analysis are the same as those for DC node-voltage analysis. Remember, equations must be solved using phasors and phasor algebra (i.e., all complex numbers).

Using the Nodal analysis theoretically, calculate the node voltages of V_A, V_B and V_C from the circuit diagram shown in Figure 1. Assume C1 = 10 µF, C2 =4.7 µF, R1 = R2 = R3= R4= 100 Ω, L1 = 6.3 mH, f =1 KHz, Supply voltage, V1 = 10 V_{Pk} with 0º phase shift. Find the practical node voltage of V_A, V_B and V_C using the Oscilloscope. Express the results in phasor form (i.e., magnitude and angle). Using the calculated data, determine the current in each branch using node-voltage. Complete Data Table 1 to understand the deviation or error. Fig 1 is showing the circuit diagram to analyze the nodal analysis.

Pre-Lab Homework:

Study the phase relation of the reactive elements and how to solve the complex impedance equations. Try to write the related equations and practice some mathematical problems to get clear idea. Observe the graphs related to parallel RLC circuit. Use PSIM to generate the output of the circuit provided in this lab sheet. Fig 2 is showing the transient simulation (from 0 to 10 ms) of the circuit Using PsPice/ LtSpice,

Apparatus:

a) Oscilloscope, b) Function generator c) Resistor: 100 Ω - 5 pcs d) Inductor: 6.3 mH e) Capacitor: 4.7 µF and 10 µF, f) Connecting wire, g) Bread board

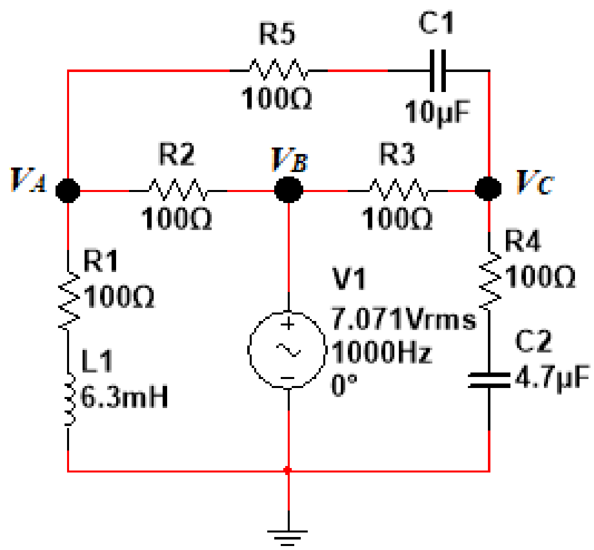

Fig 1: Circuit diagram for Nodal Analysis

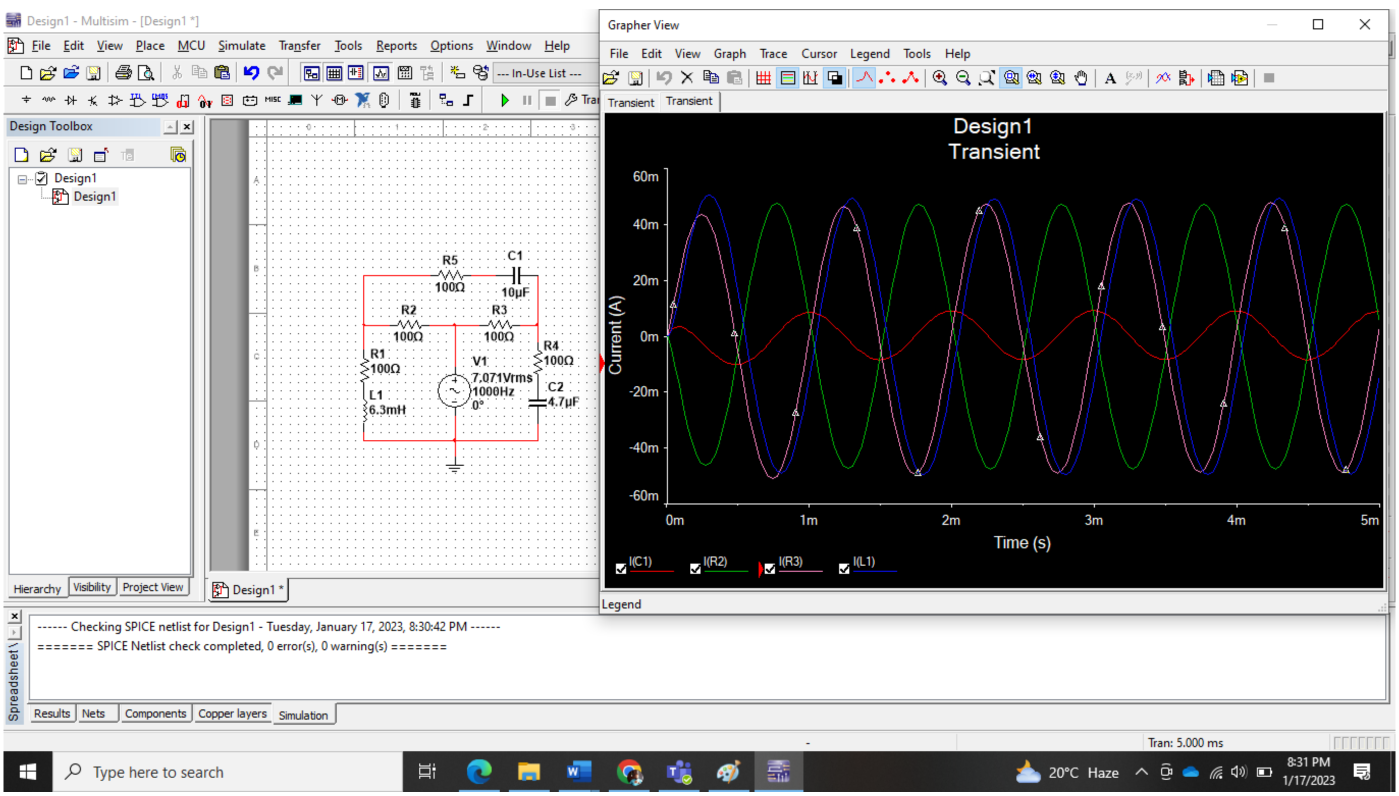

Fig 2: Simulation diagram (showing Current on each branch)

Precautions:

1. We have proceeded according to figure understanding the connections and check initially.

2. Operated the signal/function generator smoothly and connected the probes perfectly.

3. Calibrate the oscilloscope before connecting the channels across any components and ensure that there was no problem in the probes of the oscilloscope.

4. Connected the components to the breadboard smartly to ensure the connections.

Procedure:

1. Constructed the circuit as shown in Fig.1. Connected channel 1 of the oscilloscope across function generator and channel 2 of the oscilloscope across R_2

2. we have Set the amplitude of the input signal 10V peak and the frequency at 1 kHz and selected sinusoidal wave shape.

3. Measure the value of V_A and $I_{V\ A\text{-}B}$

4. Determine phase relationship between Supply voltage V and node voltage at V_A

5. Connect channel 2 of oscilloscope across R_3.

6. Determined phase relationship between the waves.

7. Measured value of V_C and $I_{V\ B\text{-}C}$.

8. Determined phase relationship between Supply voltage V and node voltage at V_C

9. Determine $I_{V\ A\text{-}C}$, $I_{V\ A\text{-}G}$ and $I_{V\ C\text{-}G}$.

10. Compare all the current found with the theoretical value and find the %Error.

Data Table:

Freq.(f) (kHz)	Supply Voltage (V)	Practical Value										Error
		$I_{V\ B\text{-}A}$		$I_{V\ B\text{-}C}$		$I_{V\ A\text{-}C}$		$I_{V\ A\text{-}G}$		$I_{V\ C\text{-}G}$		%Error= (Theoretical – Practical value/Theoretical value) *100
		Mag. $I_{VB\text{-}A}$ (mA)	Phase θ (º)	Mag. $I_{V\ B\text{-}C}$ (mA)	Phase θ (º)	Mag. $I_{V\ A\text{-}C}$ (mA)	Phase θ (º)	Mag. $I_{V\ A\text{-}G}$ (mA)	Phase θ (º)	Mag. $I_{V\ C\text{-}G}$ (mA)	Phase θ (º)	%

Question:

1. Show all the calculations along with simulation.

Reference(s):

1. Robert L. Boylestad," Introductory Circuit Analysis", Prentice Hall, 12th Edition, New York, 2010, ISBN 9780137146666.
2. R.M. Kerchner and G.F. Corcoran, "Alternating Current Circuits", John Wiley & Sons, Third Ed., New York, 1956.