AMERICAN INTERNATIONAL UNIVERSITY- BANGLADESH (AIUB)

Introduction to Electrical Circuit

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Section: L, Group: 07

LAB REPORT ON

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

Supervised By

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Abstract:

The purpose of the experiment was to develop an understanding of the method of determining voltage and current using 'Nodal Analysis' in an R-L-C AC circuit. Circuits containing R, L, and C components were constructed, and the objective was to analyze the outputs of R-L-C series-parallel combination circuits to obtain practical values as well as simulated or theoretical results. Additionally, the experiment involved determining the phase relationship between V and I in an R-L-C combination circuit and drawing a complete vector diagram to comprehend the method of using Nodal analysis.

Circuit diagram:

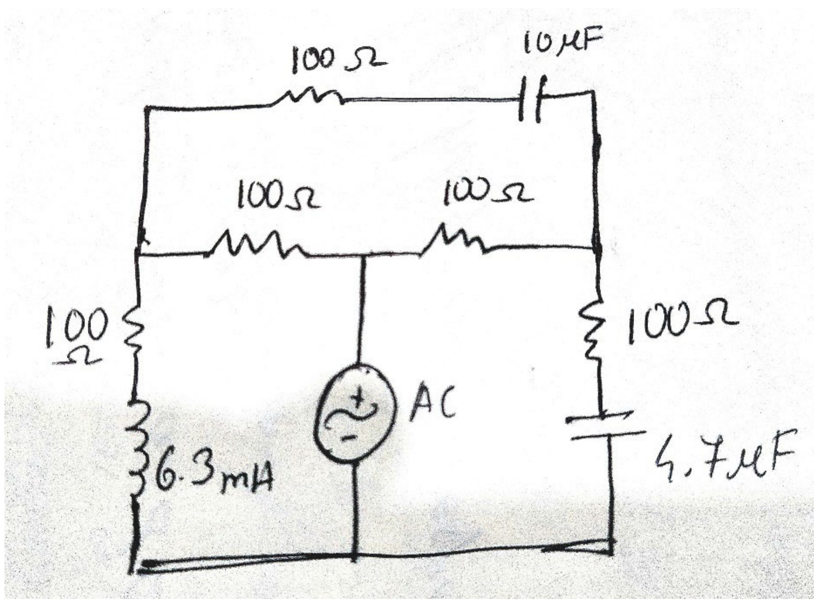


Figure 1: Circuit diagram for Nodal Analysis

Apparatus:

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

Experimental Procedure:

The circuit illustrated in Fig. 1 was successfully constructed, with channel 1 of the oscilloscope connected across the function generator and channel 2 across R2. The amplitude of the input signal was set at 10V peak, and the frequency was adjusted to 1 kHz, with a sinusoidal wave shape selected. Measurements were taken for the values of VA and the current IV A-B. The phase relationship between the supply voltage V and the node voltage at VA was determined. Subsequently, channel 2 of the oscilloscope was connected across R3, and the phase relationship between the waves was determined. The values of VC and IV B-C were measured, and the phase relationship between the supply voltage V and the node voltage at VC was determined. Further analysis involved determining IV A-C, IV A-G, and IV C-G. All the obtained currents were compared with their theoretical values, and the percentage error was calculated for comprehensive assessment..

Result analysis :

Data Table:

Freq.(f) (kHz)	Supply Voltage (V)	Practical Value										Error
		$I_{V\,B-A}$		$I_{V\,B-C}$		$I_{V\,A-C}$		$I_{V\,A-G}$		$I_{V\,C-G}$		%Error= (Theoretical – Practical value/Theoretical value) *100
		Mag. I_{VB-A} (mA)	Phase θ (º)	Mag. $I_{V\,B-C}$ (mA)	Phase θ (º)	Mag. $I_{V\,A-C}$ (mA)	Phase θ (º)	Mag. $I_{V\,A-G}$ (mA)	Phase θ (º)	Mag. $I_{V\,C-G}$ (mA)	Phase θ (º)	%
1kHz	7.07V rms	66.964	-3.34	68.212	-3.34	134.605	1.2	69.874	-24.74	69.731	15.2	5%

Simulation:

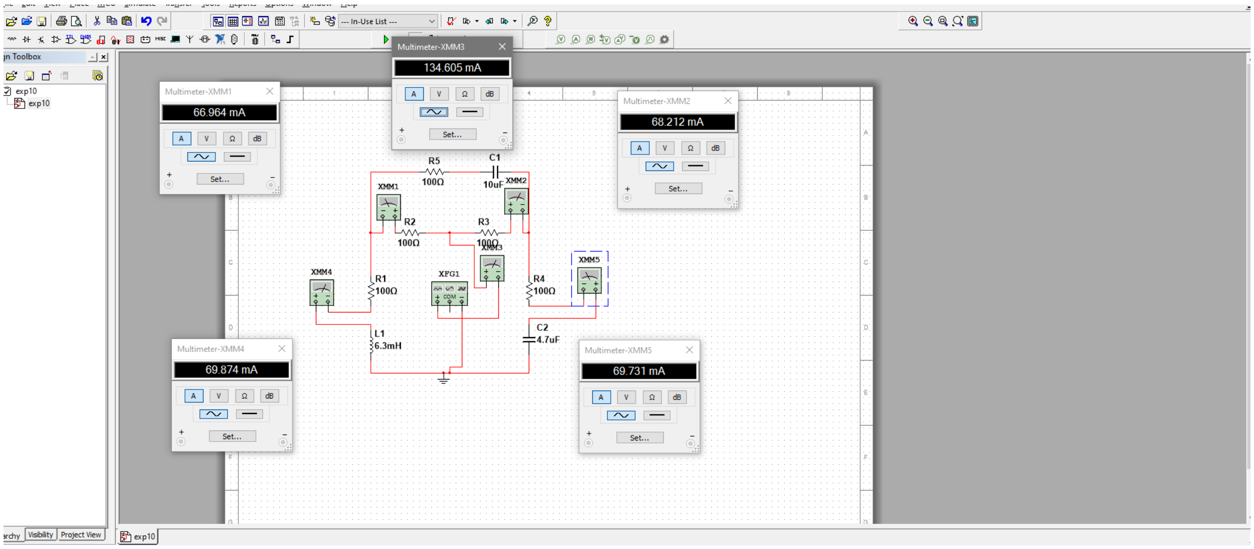
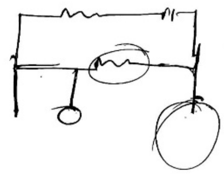


Figure: Currents for the circuit.

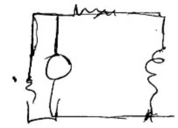
Calculation:



$R2 \parallel R3 = 50\,\Omega$

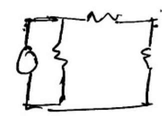
$X_{C_1} = \frac{1}{2\times\pi\times1000\times10\times10^{-6}} = 15.9\,\Omega$

$Z_{RC} = 100 - 15.9j\,\Omega$



$R_{23} \parallel Z_{RC} = \frac{(50)(100-15.9j)}{50+100-15.9j}$

$= 33.52 - 1.75j$



$\cancel{R_{23} \parallel Z_{RC}}$

$X_{C_2} = \frac{1}{2\times\pi\times1000\times4.7\times10^{-6}} = 33.86\,\Omega$

$Z_{RC_2} = 100 - 33.86j\,\Omega$

$R_{23} \parallel Z_{RC} + Z_{RC_2} = (33.52-1.75j + 100 - 33.86j)\,\Omega$

$= 133.52 - 35.61j$

$\cancel{(R_{23} \parallel Z_{RC} + Z_{RC_2}) \parallel Z_{RC}}$ $X_L = 2\pi f L = 2\times\pi\times1000\times6.3\times10^{-3}$

$= 39.58\,\Omega$

$Z_{RL} = 100 + 39.58\,\Omega$

$$(R_{23} \parallel Z_{RC_1} + Z_{RC_2}) \parallel Z_{RL} = \frac{(133.52-35.61j)(100+39.58j)}{133.52-35.61j+100+39.58j}$$

$$Z_T = 63.32 + 6.3j\ \Omega$$

$$I_s = \frac{7.07}{63.22+6.3j\ \Omega} = 0.11 - 0.011j$$

$$I_{R_L} = \frac{Z_T}{R_L} \times I_s = \frac{63.22+6.3j\ \Omega}{100} \times 0.11 - 0.011j$$

$$= 0.07 \angle -3.34°$$

$$I_{R_3} = \frac{Z_T}{R_3} \times I_s = 0.069 \angle -3.34°$$

$$I_{R23} = \frac{Z_T}{R_{23}} \times I_s = 0.14 \angle 1.2°$$

$$I_{Z_L} = \frac{Z_T}{Z_L} \times I_s = 0.069 \angle -24.74°$$

$$I_{RC_2} = \frac{Z_T}{Z_{RC_2}} \times I_s = 0.063 \angle 15.2°$$

Discussion

The purpose of the experiment was to develop an understanding of the method of determining voltage and current using 'Nodal Analysis' in an R-L-C AC circuit. Circuits containing R, L, and C components were constructed, and the objective was to analyze the outputs of R-L-C series-parallel combination circuits to obtain practical values as well as simulated or theoretical results. Additionally, the experiment involved determining the phase relationship between V and I in an R-L-C combination circuit. All of these were successfully demonstrated and found. The phase of each I was calculated through theoretical calculations and we found that there was a bit of a difference between the calculated values and practical values.

Conclusion:

By completing this experiment we had become familiar with the method of determining voltage and current using Nodal Analysis in an RLC AC circuit.