University of Victoria

ELEC 250

Linear Circuits I

Lab 2 - Phasor Analysis

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1 Object

This lab will study the steady-state responses of an RC and RL circuit when exposed to a purely sinusoidal voltage source. The current response and the phase shift of current relative to voltage will be calculated and compared with measured values.

2 Results

An Agilent 33220A signal generator was used to create the sinusoidal voltage source used in this lab. A peak-to-peak voltage of 10.5 V was used for both circuits. Different frequencies were used in each section and is discussed further in sections 2.1 and 2.2.

An Agilent DSOX-2012A oscilloscope was used to analyze the maximal current and phase shift.

2.1 RC Circuit

The circuit was connected as show in figure 1 using selectable capacitor and resistor boxes provided in the lab. A 5 nF capacitor was used in the circuit. A sinusoidal voltage source with a frequency 10 kHz was applied to the circuit.

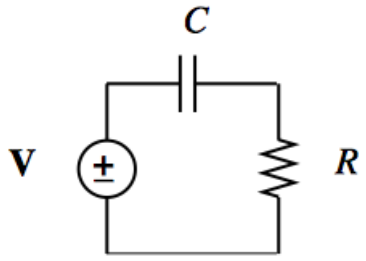

Figure 1: The RC circuit used in the lab

The expected phase shift, with current leading voltage, is given by equation (1), where $\omega = 2\pi f$. The expected maximum current is given by equation (2).

$$\tan\theta = \left(\frac{1}{\omega RC}\right) \tag{1}$$

$$I_{max} = \frac{V_{max}}{\sqrt{R^2 + (\frac{1}{C\omega})^2}} \tag{2}$$

The calculated and measured values of the current (I) and phase shift (θ) are summarized in table 1.

	Calculated		Measured	
R (kΩ)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)
1	3.15	72.56	3.10	70.89
5	1.77	32.48	1.76	31.12
10	1.00	17.67	0.98	14.89

Table 1: Calculated and measured values in the RC circuit

2.2 RL Circuit

The circuit was connected as shown in figure 2. The resistor box was reused and discrete inductors were obtained from the lab (see tables 2 and 3). The frequency of the voltage source was set to 500 kHz.

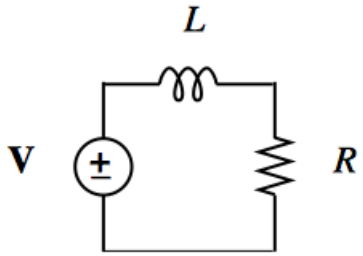

Figure 2: The RL circuit used in the lab

The expected phase shift of current with respect to voltage is given by equation (3). The negative sign indicates that voltage will lead current. The expected maximum current is given by equation (4).

$$\tan\theta = \left(\frac{-\omega L}{R}\right) \tag{3}$$

$$I_{max} = \frac{V_{max}}{\sqrt{R^2 + L^2\omega^2}} \tag{4}$$

Calculated values for each pairing of resistor and inductor is summarized in table 2. Measured results are presented in table 3.

	1μH		220μH		470μH		1000μH	
R (kΩ)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)
1	10.50	-0.18	8.64	-34.65	5.89	-55.89	3.18	-72.34
5	2.10	-0.04	2.08	-7.87	2.01	-16.45	1.78	-32.14
10	1.05	-0.02	1.05	-3.95	1.04	-8.40	1.00	-17.44

Table 2: Calculated values in the RL circuit

	1μH		220μH		470μH		1000μH	
R (kΩ)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)	I (mA)	θ ($^\circ$)
1	3.00	-84	9.00	-36	6.00	-63	3.18	-82
5	2.46	-61	2.34	-9	2.58	-25	2.66	-58
10	2.01	-51	1.17	-5	1.41	-13	2.01	-42

Table 3: Measured values in the RL circuit

3 Discussion and Conclusion