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ELEC 240
Lab 3 - Basic Circuits

Test performed: September 19,2018

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1 Objective

<<<< HEAD In this lab, we explored Kirchoff's laws, and transfer functions through the use of various circuit elements, such as potentiometers, and software, such as LT Spice

======= In the first section of this lab, we explored running various amounts of AC and DC current through a voltage divider of different voltages. We also used a potentiometer as a voltage divider and verified its accuracy. In the second portion of this lab, we measured the transfer function of an RC Circuit by measuring its phase and amplitude with various input frequencies, and we then compared it with the calculated transfer function generated using MATLAB. Finally, we simulated two different RC circuits using LTSpice software and plotted the gain of the circuit at various input frequencies. >>>>> 1db63375a68c027f2a2a70d9006851e3d113dc55

2 Materials

- Virtual Bench (Software, Oscilloscope, Function Generator, DC Power Supply)
- Computer with LTSpice Software
- BNC Male to Clips cord
- BNC T connector
- Oscilloscope Probe
- Breadboard
- 2 10 cm length wires (with 6 mm stripped on each end)
- Digital Multimeter
- $10k\Omega$ potentiometer
- 2 47Ω resistors
- 2 $1M\Omega$ resistors
- 2.2 $k\Omega$ resistor
- $2.2\mu F$ resistor

3 Test Description

In Part A of Experiment 3.1, we explored the freuqency range that the DMM on the Virtual Bench could usefully measure by outputting a sine wave from the function generator and recording the maximum voltage recorded by the DMM hooked up to this outputted sine wave. In Part B, we measured the output of a voltage divider and observed how circuits in reality deviate from ideal circuits. In Part C, we used a poteniometer as a voltage divider and verified that turning the slider in equal increments would proportionally increase the resistance of the potentiometer.

In Part A of Experiment 3.2, we measured the transfer function of an RC Circuit that we wired on the breadboard by inputting various AC frequencies and measuring and plotting the resulting voltage signal. In Part B, we simulated an RC circuit by creating a virtual circuit on LTSpice. We then performed AC analysis by plotting the gain of the RC Circuit over a wide frequency range.

3.1 Pre-Lab Calculations and Schematics

No pre-lab calculations were needed, but an understanding of how to measure a transfer function of an AC circuit was needed. Depicted below in Fig. 1 is the desired oscilloscope output overlay needed to measure the transfer function:
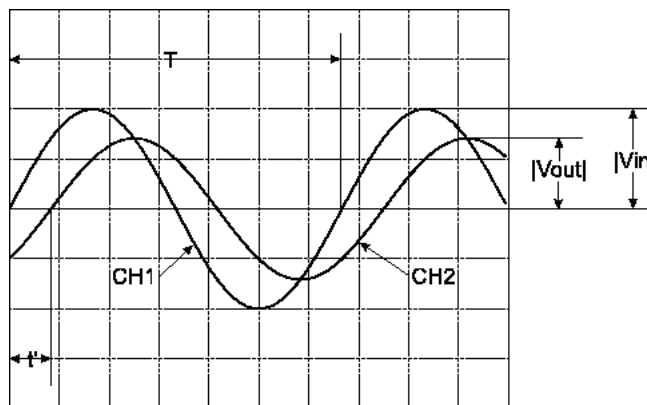

Figure 1: Circuit Output Signal Overlayed with Function Generator Output

To measure the transfer function at a given frequency, we needed to measure both $|V_{IN}|$ and $|V_{OUT}|$, which was achieved by measuring the height of the peaks of CH1 and CH2. To measure the phase Φ, we measured the horizontal distance between the peaks of CH1 and CH2. With this technique, we are able to perform AC circuit analysis in Part A of Experiment 3.2.

4 Results and Discussion

4.1 Experiment 3.1: Resistive Voltage Dividers

4.1.1 Part A

The voltage reading on the DMM by a $2V_{pp}$ sine wave is $.704 V_r ms$, or $.704\ V_i n$. The voltage reading on the DMM for a similar square wave is $1.096\ V_i n$. Then, readings were done for various frequencies for the same value sine wave as used in the initial test. The results were as follows

- 5 Hz .641V

- 50 Hz .701V

- 500 Hz .701V

- 5 kHz .49V

- 50 kHz 0V

It seems that the appropriate frequency for the DMM is 50-500 Hz to be safe, but more reasonably 10Hz-1kHz.

4.1.2 Part B

The voltage divider ratio should be $\frac{10,(10+10)}{=} V_i n$ for two 10 kOhm Resistors in series. For the sine wave, the output is $.351 V_a c$, which is 49% of the initial Voltage, consistent with the voltage divider equation At 47 Ohms the $V_o ut = .243$, which is inconsistent, with the voltage divider equation, indicating that the voltmeter may have inconsistent readings at low voltages. At 1MOhm the output voltage is .335, indicating that there may be a range of acceptable resistance for the voltmeter, just like we noted an acceptable frequency range.

4.1.3   Part C

Using the same sine wave, but wih 100 Hz, the potentiometer is connected in series and the voltage drop across it is recorded. At the midpoint, $V_out = .386 or .55V_in$ this value is reasonable within error for such an analog device. The values of the output voltage at different divisions are given below.

- 1 -.76V

- 2 -.653V

- 3 -.589V

- 4 -.506V

- 5 -.389V

- 6 -.273V

- 7 -.181V

- 8 -.076V

- 9 -0.002V

- 10-0.0V

It seems as if the values were evenly spaced as if they're were only 9 divisions, since the 9th and 10th both had 0V out.

4.2   Experiment 3.2: Filters and Transfer Function

4.3   Part A

Measuring the frequency and the amplitude of the output voltage across an RC circuit. The values recorded can be seen below

Table 1: Frequency and the amplitude of the output voltage across an RC circuit

Frequency (Hz)	Voltage (V)	Phase shift (ms)
20	.99	1.97
50	.96	1.02
100	.88	.869
200	.68	.632
500	.39	.402
1k	.16	.227
2k	.065	.119
5k	.041	.046
10k	.021	.023
20k	.010	.012

These results from Table 1 were then used plotted onto Figure ??, using MATLAB. When compared to the values of Figure ?? it can be seen that the experimental results match up with the actual results, confirming the transfer function of AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

4.3.1 Part B

The screenshot of the LT spice AC analysis of an RC circuit can be seen in figure **??**, The gain at low frequencies is 0 dB or 1 V/V. The cutoff frequency happens at approx. 250 Hz. At high frequencies the gain rolloff becomes almost linear, with a slope of -1 dB/dec. At low frequencies, the phase is 0 deg or in phase. At high frequencies the phase is -90 deg. This is because a capacitor will ideally lag in voltage when put in a circuit in series, and at low frequencies the capacitor acts more like a resistor.

After adding the

5 References

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Note (To be deleted): List any datasheets, websites, lab procedure, etc. used during the lab.

6 Conclusion

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Note (To be deleted): While the "Results and Discussion" section focused on the test results individually, the "Conclusion" discusses the results in the context of the entire experiment. Usually, the objectives given in the "Introduction" are reviewed to determine whether the experiment succeeded. If the objectives were not met, you should analyze why the results were not as predicted.

7 Errors

Your text here

Note (To be deleted): Briefly list sources of error and discuss how to eliminate or deal with them