**Laboratory 1:**

**Introduction to Laboratory Instrumentation**

Uday Mahajan Frank Qin

EE 205

January 09, 2018

1. **INTRODUCTION**

This lab is to familiarize with the basic electronics lab safety rules and basic lab devices usage. The devices include digital multimeters, DC power supplies, function generators, oscilloscopes, and resistors. This lab also helps us to familiarize construction of DC/AC voltage dividers consisting of resistors.

1. **LABORATORY SAFETY**

*A. Task 1*

The three items that our group discussed for the “safety moment” were for this lab were as follows

* *Hazard 1:* Always check to see that the power switch is OFF before plugging into the outlet. Also, turn instrument or equipment OFF before unplugging from the outlet.
* *Hazard 2:* Keep the body, or any part of it, out of the circuit. No part of a live circuit should be touched by the bare hand. Also, keep fluids or food away from equipment.
* *Hazard 3:* Where interconnecting wires and cables are involved, they should be arranged so people will not trip over them.

1. **BASIC LABORATORY INSTRUMENTS**

No tasks performed in this section.

1. **USING THE MULTIMETER**
2. *Task 2.a.*

The multimeter was turned on and the test leads were plugged in as mentioned in the lab instructions. We then set the measurement function to Voltage (Fluke: V DC, BK Precision: ⩢) and measured the time we had to wait for the voltage reading to stabilize and if it did stabilize or not for the two 9V batteries and one 1.5V battery. The following results were obtained.

TABLE I

STABALIZATION TIME

|  |  |  |
| --- | --- | --- |
| Battery Type (V) | Time (s) | Did it ever completely stabilize? |
| 9 | 20 | Never completely. |
| 9 | 26 | Never completely. |
| 1.5 | 3 | Yes. |

1. *Task 2.b.*

When switched to a higher scale, less significant digits were provided. When switched to a lower scale, more significant digits were provided. The multimeter does not show a reading when the scale is set too low. In this case, at most 5 significant digits were shown when the scale was set to 2 digits before the decimal point.

1. *Task 2.c.*

The readings became negative.

1. *Task 2.d.*

TABLE II

RESISTOR COLOR CODE PRACTICE

|  |  |
| --- | --- |
| RESISTANCE | COLOR CODE |
| *500Ω* | *Green-Black-Brown* |
| 1kΩ | *Brown-Black-Red* |
| 1MΩ | *Brown-Black-Green* |
| 8.2kΩ | *Grey-Red-Red* |
|  |  |
| COLOR CODE | RESISTANCE |
| *Yellow-Black-Red* | *4kΩ* |
| White-Brown-Orange | *89.42kΩ* |
| Red-Black-Green | *1.96MΩ* |
| Yellow-Orange-Black | *43.19Ω* |

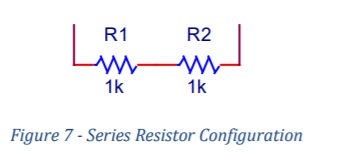
1. *Task 2.e.*

The resistance of the 1k*Ω* resistor in the lab kit was measured using the multimeter, the value was found to be 1.001 k*Ω.*

1. *Task 2.f.*

Using two 1k*Ω* resistors in the lab kit, and the breadboard, we connected the resistors in series as shown in the figure below and measured the equivalent resistance using the multimeter and got the following results:

*Using Hand:*



= R1 + R2  1 k  1 k  2k

**(1)**

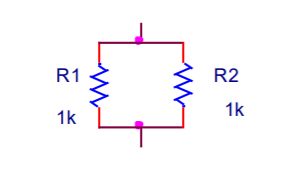
*Using Multimeter:*

Figure 1- Series Resistor Configuration

2.005 V

1. *Task 2.g.*

Using two 1k*Ω* resistors in the lab kit, and the breadboard, we connected the resistors I parallel as shown in the figure below and measured the equivalent resistance using the multimeter and got the following results;

*Using Hand:*

= k (**2)**

*Using Multimeter:*

Figure 2 - Parallel Resistor Configuration

501.8 

1. **USING THE DC POWER SUPPLY**
2. *Task 3*

We turned the power supply on and set the Tracking to “Indep”. Next, we set the

“Amps”/ “Volts” slider to volts and rotated the knob such that one set of output terminals

is outputting 5.00 V. Then we connected a red alligator clip lead to the “+” and a black lead to “-” terminal. Connect the two leads together resulting in voltage being dropped to 0V. Now we set the “Amps/Volts” slider to “Amps” and adjusted the current limit to 100mA to 0.1A. The output leads were then connected to the input terminals of the Multimeter using the Alligator Clip Leads and the multimeter range was set to the 20V range and following data was obtained.

* + *DC Voltage between ground and negative terminal:*  4.956 V DC
  + *DC Voltage between ground and positive terminal:* 4.974 V DC
  + *DC Voltage between negative and positive terminal:* 15.017 V DC

1. **USING THE SIGNAL GENERATOR**
2. *Task 4.a.*

No required work for this task.

1. *Task 4.b.*

No required work for this task.

1. *Task 4.c.*

No required work for this task.

1. *Task 4.d.*

No required work for this task.

1. *Task 4.e.*

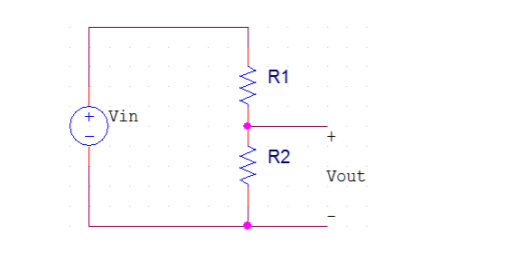
No required work for this task.

1. *Task 4.f.*

No required work for this task

**7. DC VOLTAGES IN A VOLTAGE DIVIDER**

1. *Task 5.a.*

The voltage divider circuit was set up as described in the figure below where *R1 = 1.017* Ω; *R2 = 1.013* Ω;*Vin= 4.963 V***.** When calculating the *Vout,* the following results were obtained.

By Hand: Vout = Vin = 4.963() = 2.477 V

Using Multimeter:*R1 = 1.017* Ω **;** *R2 = 1.013* Ω;*Vin= 4.963 V & Vout= 2.477 V*

1. *Task 5.b.*

Now the resistors.

TABLE II

DC VOLTAGE DIVIDER

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Task | R1(Ω) | R2(Ω) | Vout (VDC) | Power R2 (W) |
| 5a | 1k | 1k | 2.476 | 3.065 × 10-3 |
| 5b | 1k | 100k | 4.912 | 2.389 × 10-4 |
| 5b | 100k | 1k | 0.050 | 2.475 × 10-8 |
| 5b | 100k | ∞ (Open Circuit) | 4.913 | ∞ |
| 5b | ∞ (Open Circuit) | 100k | 0.000 | ∞ |

1. **AC VOLTAGE SOURCE IN A VOLTAGE DIVIDER**
2. *Task 6.a*

The signal generator was set to be outputting a sine wave with 1V amplitude with a DC offset of 2V at a frequency of 100Hz.probe of the scope was connected to the output cables of the signal generator to verify that the equipment is set up correctly. The signal generator was set such that the oscilloscope showed 2V, 2Vpp and 2V offset at 100Hz. The values shown in the signal generator were recorded as follows.

Amplitude = 0.880 V; Offset = 2.050 V

1. *Task 6.b.*

TABLE III

AC VOLTAGE DIVIDER

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Frequency = 100 Hz | | | | Frequency = 1 MHz | | | |
|  | **Vin** | | **Vout** | | **Vin** | | Vout | |
| Vp-p  (VAC) | Voffset  (VDC) | Vp-p  (VAC) | Voffset  (VDC) | Vp-p  (VAC) | Voffset  (VDC) | Vp-p  (VAC) | Voffset  (VDC) |
| R1=R2=1kΩ | 2 | 4 | 1.12 | 2.00 | 1.82 4.00 | | 1.00 2.00 | |

1. *Task 6.c.*

Changing of frequency does not have any effect on Vout.

1. *Task 6.d*

The R1 and R2 were set to be 1kΩ and 100 kΩ respectively, the Vin, Offset, frequency was set to 1Vpp, 0V, 1kHz respectively and it was found that Vpp of Ch1-Ch2 was 220mV and that Ch1-Ch2 is the voltage across R1

1. **CONCLUSION**

Starting from the *Task 1*, we reviewed the lab safety rules. We, in task 2, then practiced using the digital multimeter, breadboard and resistors and found the resistance of resistors in series is the sum of their resistance, and the conductance of resistors in parallel is the sum of their conductance. In *Task 3*, we practiced using the DC power supply and in *Task 4.a – 4.f*, we practiced using the function generator. Then we used resistors to build a DC voltage divider and found that its output voltage measured with the multimeter matches our calculation. In the end, we used resistors to build a AC voltage divider and found that the output voltage is independent from the input frequency.

In this lab, we learned to use a digital multimeter to measure voltages and resistances, and compare the results obtained to hand calculations. We also learned to use a laboratory power supply to provide DC voltages, a signal generator to produce sinusoidal waveforms at different frequencies and offsets. Characterize a DC voltage divider and examine AC voltage dividers consisting of resistors. Overall, we are convinced with the results we obtained from the experiments.

1. **SUGGESTIONS**

Fortunately, unlike some other groups we did not encounter any equipment malfunctions. We also found out the lab instructions to be straightforward and helpful during the lab and do not have any relevant suggestions for improving the lab procedures at this point.