EEE 117 Laboratory
Instructor: Sergio Aguilar

Lab 2: Calculation of Internal Resistance of Voltmeter, Ammeter and Scope

Lab Report: Sergio Zavala

Lab Session: Wednesday (32490)

Due Date of lab: February 21, 2018

Date of the lab: February 7, 2018

Lab partner(s): Talal Jawaid and Amrit Singh

Introduction:

In this lab each team will have the opportunity to design a circuit to model the Voltmeter, Ammeter, and Scope. You shall calculate the internal resistance of the previous mentioned meters. You have to make sure that the meter circuit is connected to the output port of the circuit whose measurements are been calculated. A lab safety for this lab will be that the current flowing into the ammeter never exceeds $imax = 0.2\,A$.

Procedure:

In order to calculate the internal resistance of voltmeter, ammeter and scope you will have to design a simple or complicated circuit is up to you. Your circuit may have a source and its internal resistance in series and parallel with some loading. If you are having trouble with designing a circuit think of a circuit that KCL, KVL, and Voltage rule may be applicable. While doing this lab keep in back of your mind that your load resistor should be higher than the internal resistance of the supply circuit. The calculation for the ammeter resistance will be a simple calculations, on the contrary voltmeter and scope calculation will be a little more difficult and the algebra can get nasty depending on how your circuit looks. Once you have designed a circuit show a circuit model of the voltmeter and in part two show a model of the ammeter. Your circuit model should include the internal resistance of the meter. You will be calculating Ri (internal resistance) value. Here is note to help you calculate the internal resistance for voltmeter it should be in the high KiloOhms. The internal resistance of the ammeter should be in low milliOhms. Repeat the steps mentioned above for an Ammeter internal resistance calculation.

Analysis and Data:

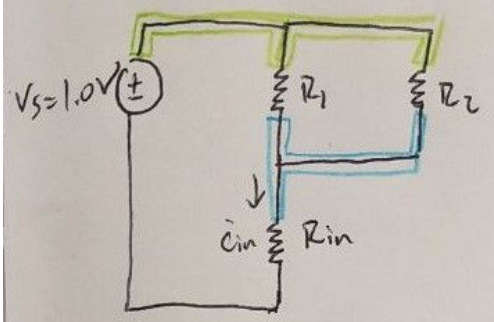
Below I will include the circuit that I designed as well as my calculations to determine the internal resistance of voltmeter, ammeter and scope.

Ammeter:

First I saw that R1 and R2 are in parallel I combined both of them I got 5.056 ohms. Then, Rin and R12 are in series so I knew they shared the same current. I solved for the current and then I used KVL to find the internal resistance of the ammeter.

Lab 2

Ammeter



$R_1 = 10.035\,\Omega$

$R_2 = 10.190$

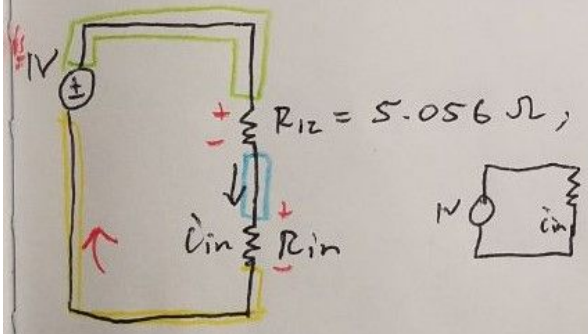
$\therefore R_1 \parallel R_2$

$$\frac{1}{R_{parallel}} = \frac{1}{10.035} + \frac{1}{10.190}$$

$$R_{parallel} = \frac{1}{0.1977866}$$

$$R_{12\ parallel} = 5.056\,\Omega$$

reduced New^ Circuit



$R_{eq} = R_{12} = 5.056\,\Omega$

$i_{in} = 1/5.056\,\Omega$

$i_{in} = 0.092\,A$

$$-V_s + i_{in}(5.056 + R_{in}) = 0$$

$$i_{in}(5.056 + R_{in}) = V_s$$

$$0.092(5.056) + 0.092 R_{in} = 1$$

$$0.465 + 0.092 R_{in} = 1$$

$$0.092 R_{in} = 0.535$$

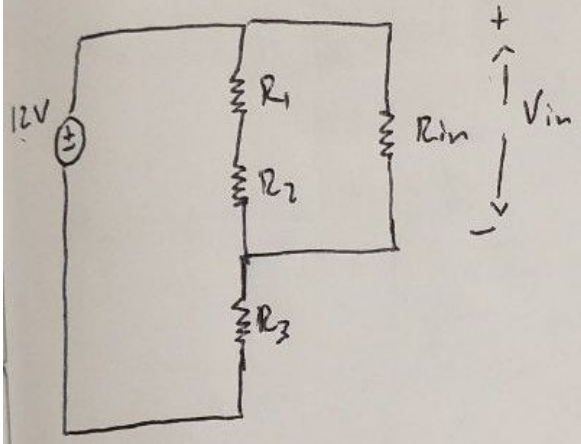
$$\boxed{R_{in} = 5.82\,\Omega}$$

Voltmeter

$R_1 = 6.285\,M\Omega$ $\quad V_{in} = 9.95V$

$R_2 = 6.292\,M\Omega$

$R_3 = 6.319\,M\Omega$



R_1 in series R_2, $V = 12V$, $V_{in} = 9.95V$

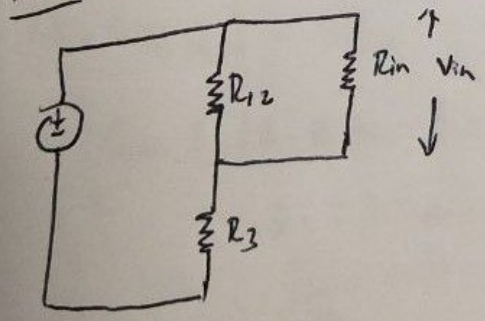
$R_{12} = R_1 + R_2$

$R_{12} = 6.292 + 6.285$

$R_{12} = 12.577\,M\Omega$

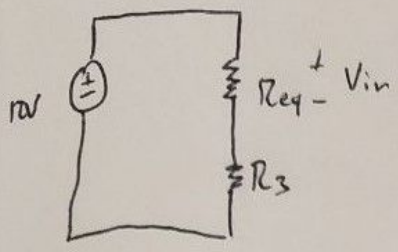
Note: $R_{12} \parallel R_{in}$

Now



$$R_{eq} = \frac{R_{12} \times R_{in}}{R_{12} + R_{in}}$$

$$R_{eq} = \frac{12.577\,R_{in}}{12.577 + R_{in}}$$



$$V_{in} = 12 \times \frac{R_{eq}}{R_{eq} + R_3}$$

$$9.95 = 12 \times \frac{\frac{12.577 R_{in}}{12.577 + R_{in}}}{\frac{12.577 R_{in}}{12.577 + R_{in}} + 6.319}$$

$$\frac{9.95}{12} = \frac{12.577 R_{in}}{12.577 R_{in} + 6.319 (12.577 + R_{in})}$$

$$0.8291 = \frac{12.577 R_{in}}{12.577 R_{in} + 6.319 R_{in} + 79.474}$$

$$18.896 R_{in} + 79.474 = 15.169 R_{in}$$

$$R_{in} (18.896 - 15.169) = -79.474$$

$$3.727 R_{in} = -79.474$$

$$\boxed{R_{in} = -21.323 \, M\Omega}$$

Vscope = 5.75V reverse polarity

Conclusion:

In this lab I learned that to calculate the internal resistance of voltmeter depending on the circuit you have the algebra can get hectic. I learned that to solve for the internal resistance for the ammeter is straightforward as long as you have designed a simple circuit with a few resistors. I calculated both of the internal resistance for voltmeter and ammeter and I noticed that the internal resistance of voltmeter was in the high KiloOhms. The internal resistance for the ammeter was in the low milliOhms (5.82MOhms). In this experiment I calculated the internal resistance of voltmeter and ammeter. The volts for the scope was 5.75 V reverse polarity.