Lab Session 01
Introduction to Laboratory Equipments

Objective:

In this lab students will learn the basics of operating a digital multimeter, function generator , an oscilloscope and multisim simulation that are used extensively in circuits and electronics.

Equipments required:

- Digital Multimeter
- Function Generator
- Digital Storage Oscilloscope
- Bread Board

Theory:

The Function Generator (SG2120):

Function generators generate various waves, with the most useful of them (for our purposes) being sine waves. Function generators allow you to set the amplitude, frequency and shape (sine, triangular, square) of the wave. Sometimes they allow you to set the dc offset, which is simply a dc voltage added to the oscillating signal. The front panel of the function generator is shown in figure below.

Fig 1.1 Function Generator

The main characteristics of the function generator are:

- Shape: sine, square, or triangle waves.
- Frequency: inverse of the period of the signal; units are cycles per second (Hz)
- V_{pp}: peak to peak Voltage value of the signal
- DC Offset: constant voltage added to the signal to increase or decrease its mean or average level. In a schematic, this would be a DC voltage source in series with the oscillating voltage source.

Specifications:

Output Frequency 10mHz ~ 20MHz

Output Amplitude 10mv$_{p-p}$ ~ 20V$_{p-p}$

The Oscilloscope (UTD2052CL)

Oscilloscopes are very useful instruments that are used to measure and display a variety of signals. In this lab students will use the oscilloscope to measure voltage, time and frequency. Oscilloscopes vary widely depending on the manufacturer and the model but the basic operation remains the same. Most oscilloscopes will have 2 or 4 channels normally labeled either 1, 2,… or A,B,. . . . Using these channels you can input more than one signal for comparison and analysis. The front panel of the oscilloscope is shown in figure below.

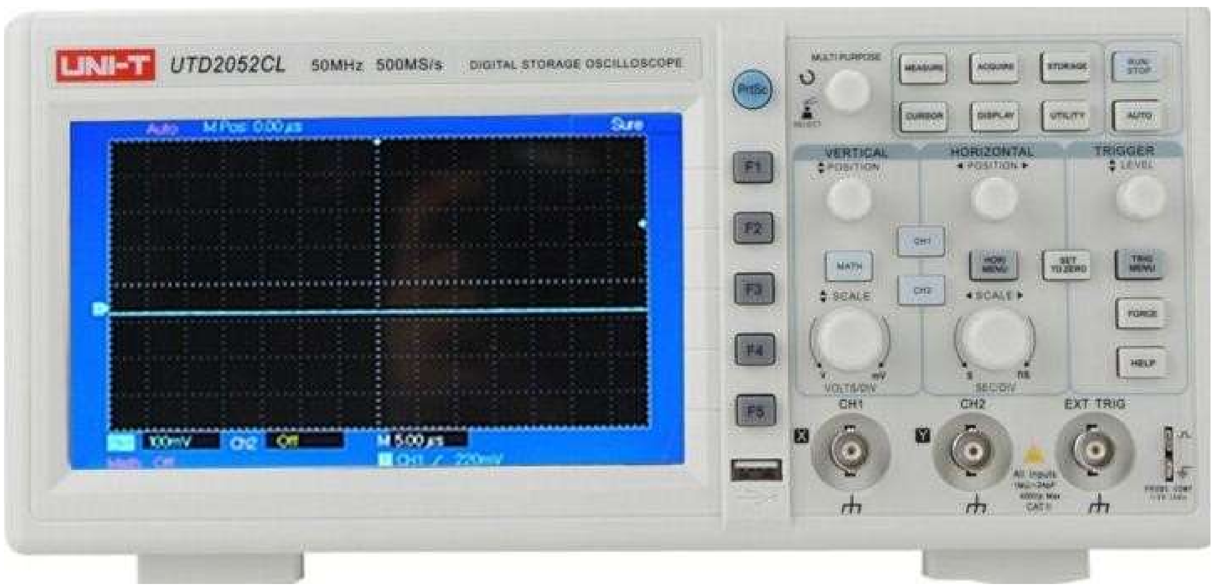

Fig 1.2 Oscilloscope In

general an oscilloscope has the following controls:

- Position: positions knobs (Vertical or Horizontal) shift the trace around the screen.
- Vertical sensitivity or V/div or V/cm: the gain that must be applied to the input to control the amount of signal displayed per division (Figure 2(c)).
- Sweep time or time/div: controls the time it takes to sweep the screen and show the signal. The higher the number is the more compact the signal will look.
- Source or Trigger Source: selects the source to trigger the sweep. Common sources are (a) internal - the input signal controls the triggering and you can choose which channel to use; (b) line - selects the 60Hz line voltage as the trigger signal; (c) Ext - an external signal is used to trigger. At this time you will always be using the internal trigger.

In addition to these controls you will have menus that allow you to measure different values of the signal such as peak or peak-to-peak voltages, phase, frequency, etc. You also have two vertical and two horizontal cursor lines that you can move. If you are using the vertical lines, the oscilloscope will display the time difference between them. On the other hand, if you are using the horizontal lines, the oscilloscope will display the voltage difference between them.

The Digital Multimeter:

A Multimeter is an electronic device that is used to make various electrical measurements, such as AC and DC voltage, AC and DC current, and resistance. It is called a Multimeter because it combines the functions of a voltmeter, ammeter, and ohmmeter. Multimeter may also have other functions, such as diode test, continuity test, transistor test, TTL logic test and frequency test.

Parts of Multimeter

- Display: The display usually has four digits and the ability to display a negative sign. A few multimeters have illuminated displays for better viewing in low light situations.
- Selection Knob: The selection knob allows the user to set the multimeter to read different things such as milliamps (mA) of current, voltage (V) and resistance (Ω).
- Ports: Two probes are plugged into two of the ports on the front of the unit. COM stands for common and is almost always connected to Ground or '-' of a circuit. The COM probe is conventionally black but there is no difference between the red probe and black probe other than color. 10A is the special port used when measuring large currents (greater than 200mA). mAVΩ is the port that the red probe is conventionally plugged in to. This port allows the measurement of current (up to 200mA), voltage (V), and resistance (Ω). The probes have a banana type connector on the end that plugs into the multimeter. Any probe with a banana plug will work with this meter.

Fig 1.3 Digital Multimeter Input

Jacks:

The black lead is always plugged into the common terminal. The red lead is plugged into the 10 A jack when measuring currents greater than 300 mA, the 300 mA jack when measuring currents less than 300 mA, and the remaining jack (V-ohms-diode) for all other measurements.

Fig 1.4 Input Jacks

Procedure for Measurement

Voltage Measurement

D.C. / A.C. Voltage Measurement Connect the positive (red) test lead to the ‘V/mA’ jack socket and the negative (black) lead to the ‘COM’ jack socket.

- Set the selector switch to the desired mV D.C./D.C.V/A.C.V range.
- Connect the test leads to the circuit to be measured.
- Turn on the power to the circuit to be measured; the voltage value should appear on the digital display along with the voltage polarity (if reversed only).

Fig 1.5 Voltage Measurement

Current Measurement

- Connect the positive(red) test lead to the ‘V/mA’ jack socket and the negative(black) lead to the ‘COM’ jack socket(for measurements up to 200mA). For measurements between 200mA and 10A connect the red test lead to the ‘10mA’ socket. Set the selector switch to the desired uA/mA/A range.
- Open the circuit to be measured and connect the test leads in SERIES with the load in which current is to be measured.
- To avoid blowing an input fuse, use the 10A jack until you are sure that the current is less than 300 mA. Turn off power to the circuit. Break the circuit. (For circuits of more than 10 amps, use a current clamp.) Put the meter in series with the circuit and turn power on.

Resistance Measurement

- Connect the positive(red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket.
- Set the selector switch to the desired 'OHM Ω'.
- If the resistance to be measured is part of a circuit, turn off the power and discharge all capacitors before measurement.
- Connect the test leads to the circuit to be measured.
- The resistance value should now appear on the digital display.
- If the resistance to be measured is part of a circuit, turn off the power and discharge all capacitors before measurement.

Continuity Test

This mode is used to check if two points are electrically connected. It is often used to verify connectors. If continuity exists (resistance less than 210 ohms), the beeper sounds continuously.

- Connect the positive (red) test lead to the 'V/mA' jack socket and the negative (black) lead to the 'COM' jack socket.
  Set the selector switch to the position.
- Connect the test leads to two points of the circuit to be tested. If the resistance is in Ohms, the buzzer will sound.
- If the resistance to be measured is part of a circuit, turn off the power and discharge all capacitors before measurement.

Diode Test

- Connect the positive (red) test lead to the 'V/mA' jack socket and the negative(black) lead to the 'COM' jack socket
- Set the selector switch to the position.
- Connect the test leads to be measured.
- Turn on the power to the circuit to be measured and the voltage value should appear on the digital display.

Bread Board:

Bread Board is an array of horizontal and vertical wires inside the body of the bread board, and upper side of it is perforated to insert wires in it. Bread board is used for checking circuit before printing it on PCB. It can also be used for making temporary circuit.

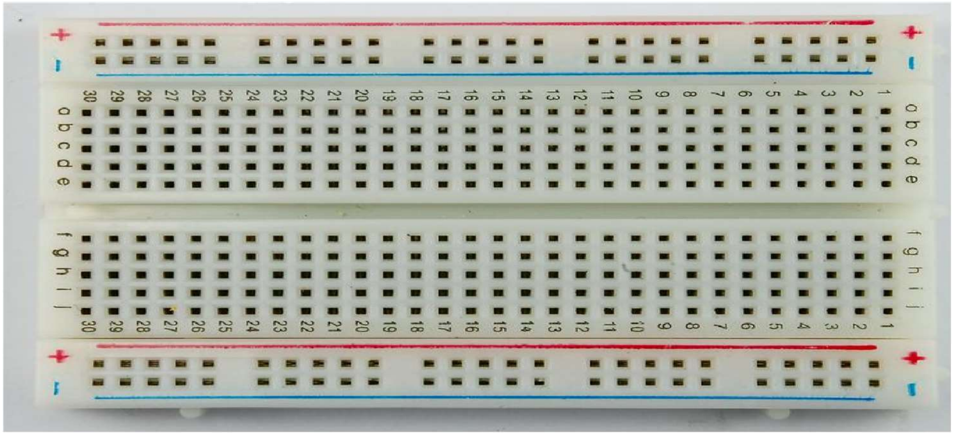

Fig 1.6 Breadboard Lab

Procedure:

1.Connect function generator output at the input of CRO at channel 1 or at channel 2.
2.Select proper channel i.e. if signal is connected to channel 1 select CH1 and if signal is connected to channel 2 select CH2.
3.Adjust Time/Div knob to get sufficient time period displacement of the wave on the CRO screen. With fine tuning of time/div make the waveform steady on screen.
4.Use triggering controls if waveform is not stable.
5.Keep volt/div knob such that waveform is visible on the screen without clipping.
6.Measure P-P reading along y-axis. This reading multiplied with volt/div gives peak to peak amplitude of the AC input wave.
7.Measure horizontal division of one complete cycle. This division multiplied by Time/Div gives time period of the input wave.
8.Calculate frequency using formula f = 1/T.

Note down your readings in the observation table

Observations:

Task 1:

Calculation of frequency on waveform basis:							
Function	Vertical Division	Vertical Sensitivity	Amplitude	Horizontal Division	Horizontal Sensitivity	Time Period	$f = \frac{1}{T}$
	(a)	V/div (b)	V_{P-P} (axb)	(c)	Time/div (d)	sec (cxd)	Hz
Sine							
Square							
Triangular							

Table 1.1

Task-2:

Draw waveforms using Function Generator & Oscilloscope, and plot it on graph paper. Sine Wave:

$V_{in} = 3\,V\,(p-p), \quad f = 0.5\,kHz$

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Square Wave:

$V_{in} = 4\,V\ (p-p), \quad f = 2.5\ kHz$

Triangular Wave:

$V_{in} = 5\,V\ (p-p), \quad f = 2.75\ kHz$

Precautions:

For Digital multimeter

- Voltage should always be measured in *parallel*.
- Current should always be measured in *series*.
- Switch off circuit supply before measuring resistance of a resistor connected in circuit, and take out the resistor from circuit.

For Breadboard

- Before implementing circuit on it determine its continuity.

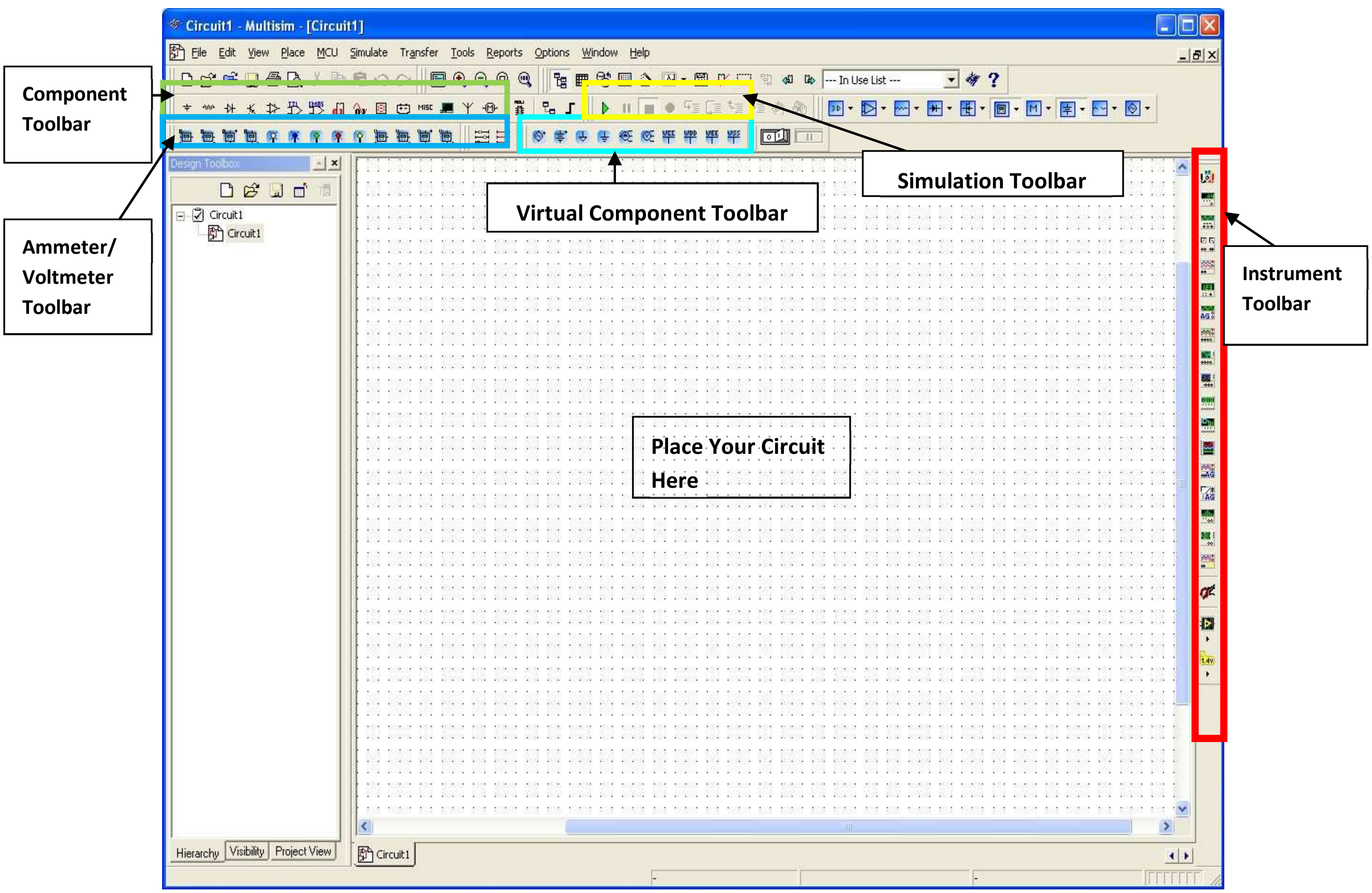
For Function generator do not exceed the values provided in the specifications.

Remember to calibrate Oscilloscope probe.

MULTISIM TUTORIAL

Start

Click on Start → All Programs → National Instruments → Circuit Design Suite 10. 0 → Multisim.



1. Open/Create Schematic

A blank schematic Circuit 1 is automatically created. To create a new schematic click on File – New – Schematic Capture. To save the schematic click on **File /Save As**. To open an existing file click on **File/ Open** in the toolbar.

2. <u>Place Components</u>

To Place Components click on **Place/Components.** On the Select Component Window click on **Group** to select the components needed for the circuit**.** Click OK to place the component on the schematic.

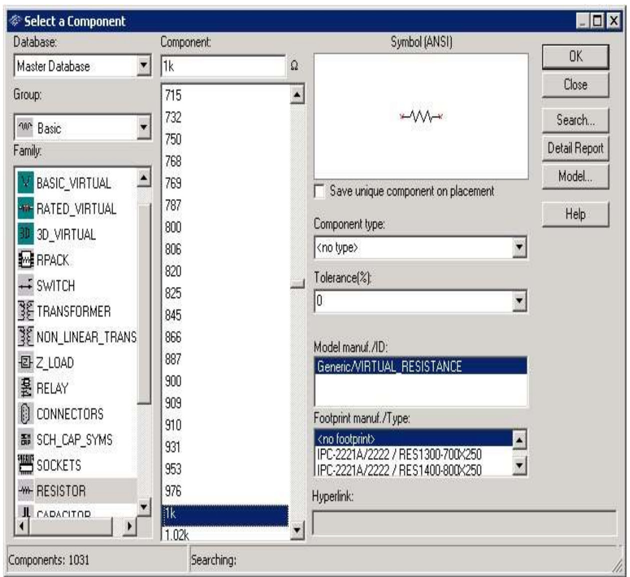


Figure 1.7: Select Resistor

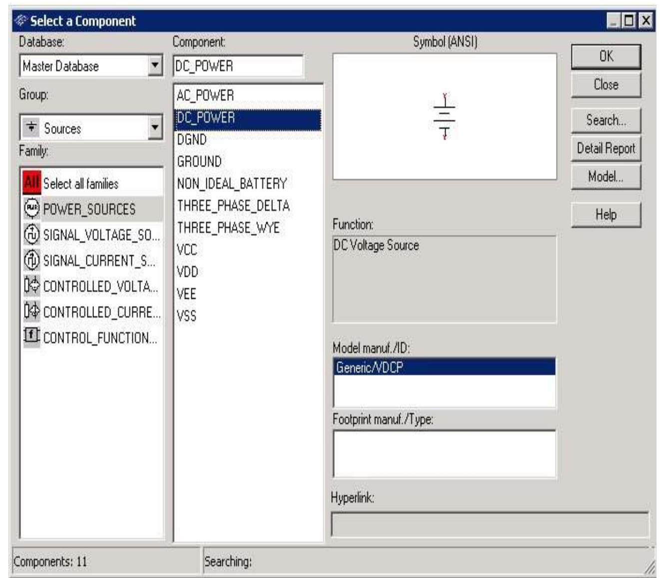


Figure 1.8: Select DC voltage

For example to select resistors and the DC source shown in Figure 3 click on **Place/ Components**. In **Group** select **Basic** scroll down to Resistors and select the value of the resistor needed to construct the circuit, for this example select 1k. To place DC source click on Sources in **Group** and select DC Source. As shown in Figure 1 and Figure 2 respectively.

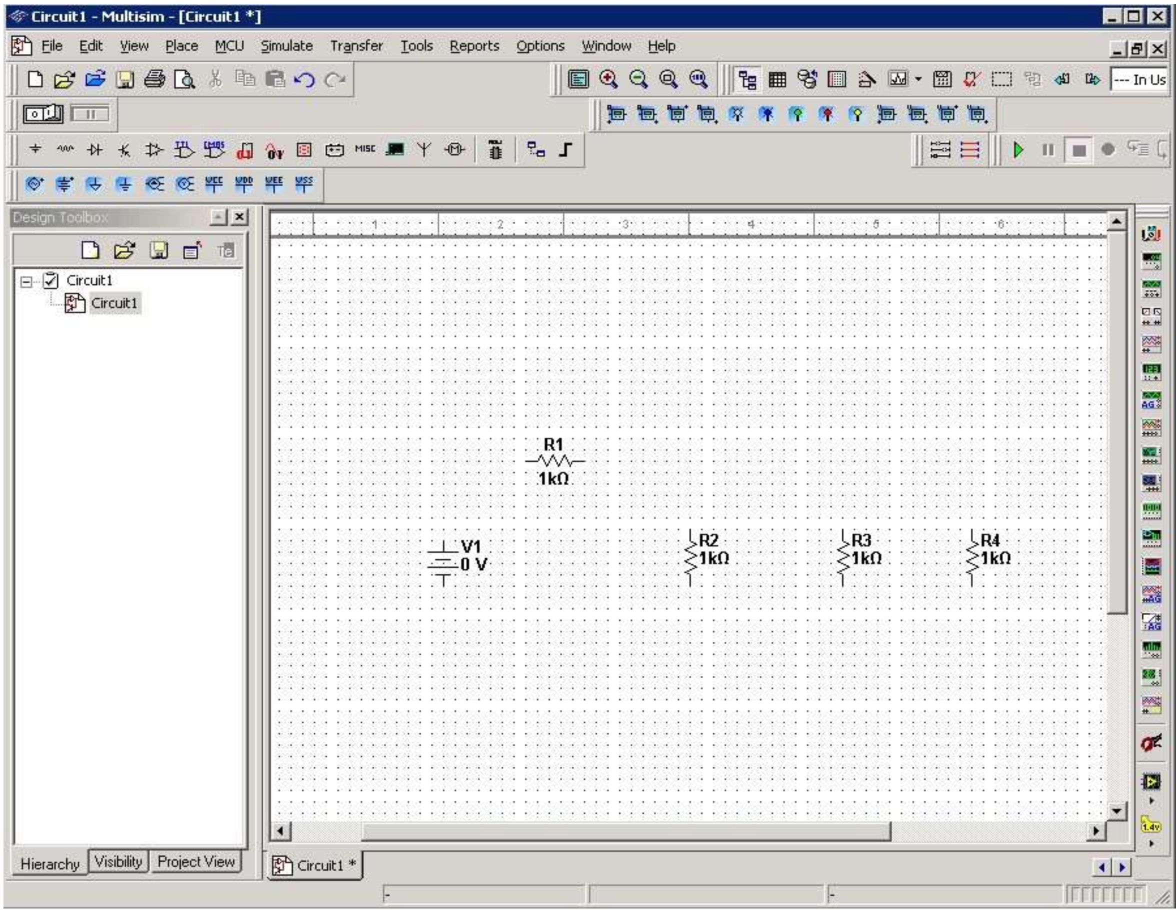


Figure 1.9: DC Source & Resistors

Virtual Components

Components can also be place on the circuit using **Virtual components**. Click on View – Toolbars and select the toolbar needed for the circuit.

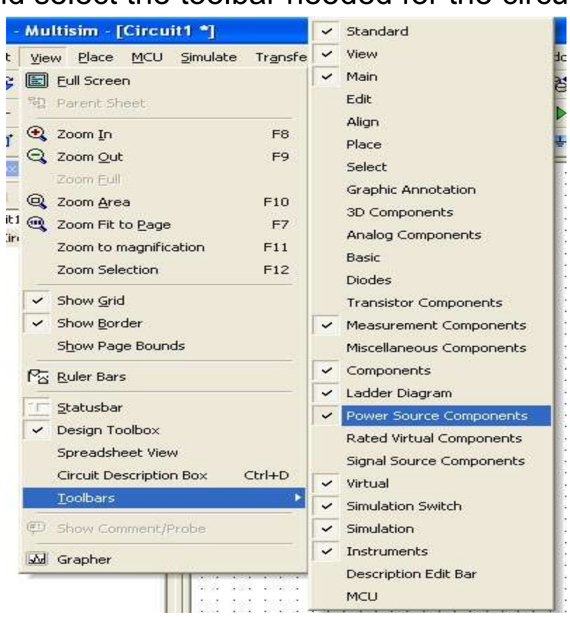


Figure 1.10: Virtual Components

4. Rotate Components

To rotate the components right click on the Resistor to flip the component on 90 Clockwise (Ctrl +R) and 90 Counter Clockwise (Ctrl+Shift+R).

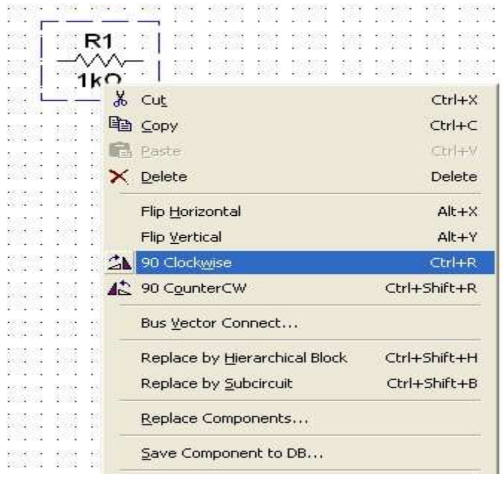


Figure 1.11: Rotate Components

5. Place Wire/Connect Components

To connect resistors click on **Place/Wire** drag and place the wire. Components can also be connected by clicking the mouse over the terminal edge of one component and dragging to the edge of another component. Reference Figure 6.

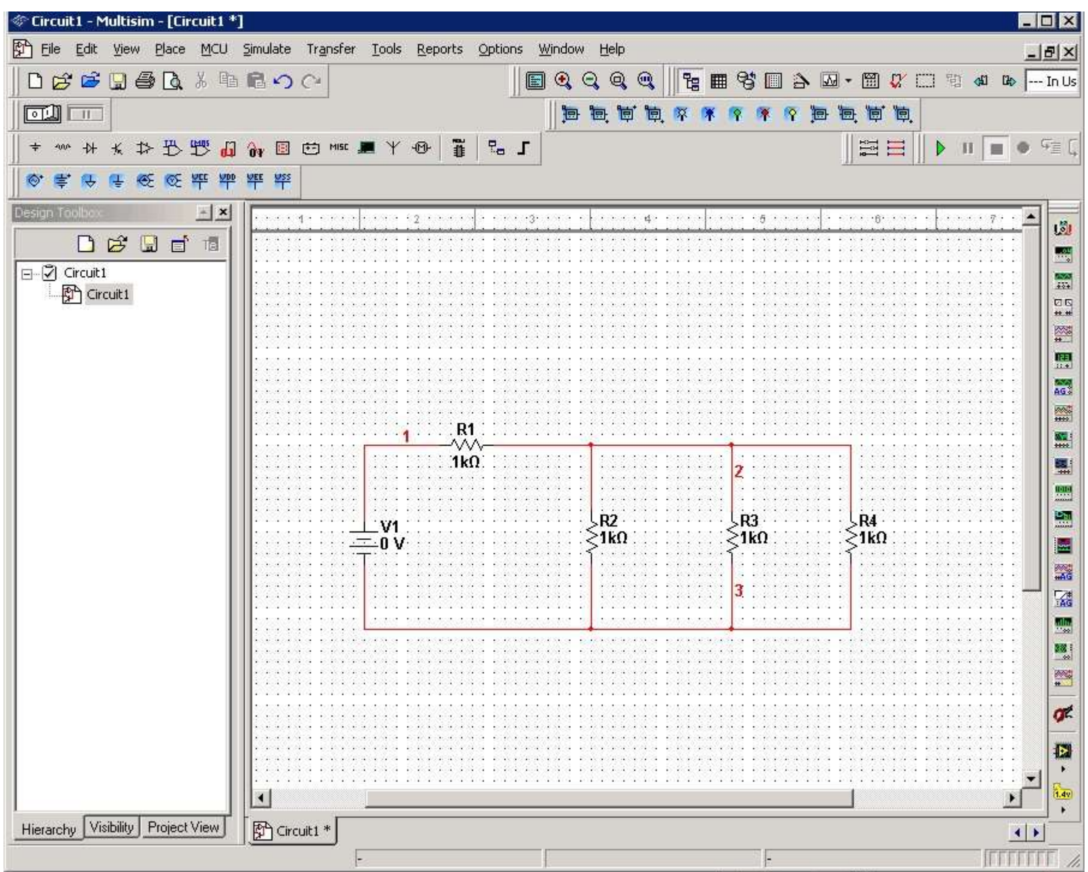


Figure 1.12: Place/ Wire

6. <u>Change Component Values</u>

To change component values double click on the component this brings up a window that display the properties of the component. Reference Figure 7. Change R1 from 1k Ohm to 10 Ohms, R2 to 20 Ohms, R3 to 30 Ohms, and R4 to 40 Ohms. Also change the DV source from 0 V to 20 V. Figure 8 shows the completed circuit

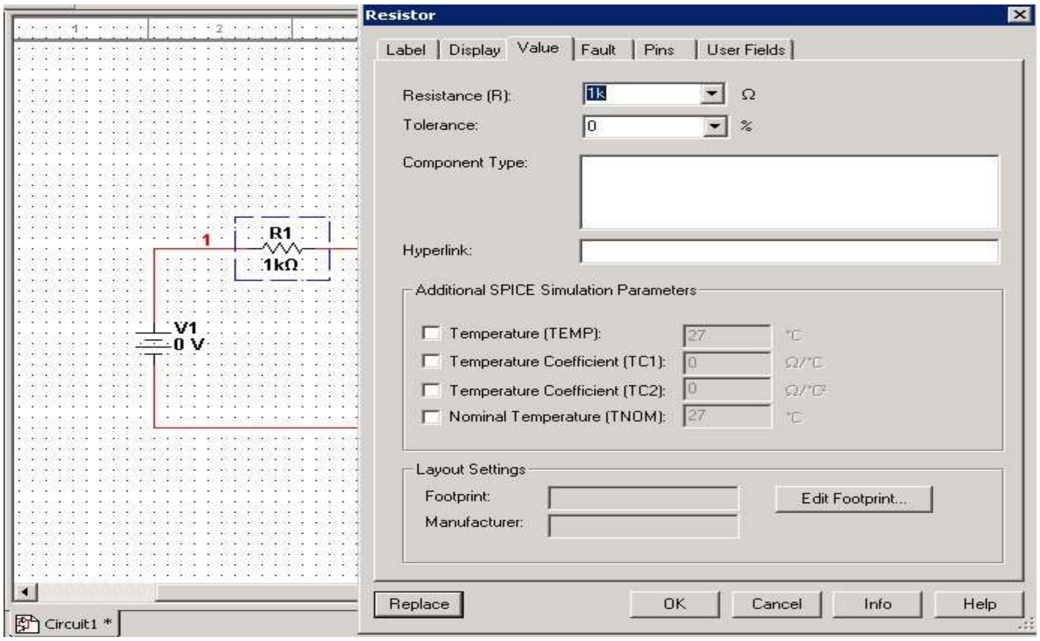


Figure 1.13: Change Component Values

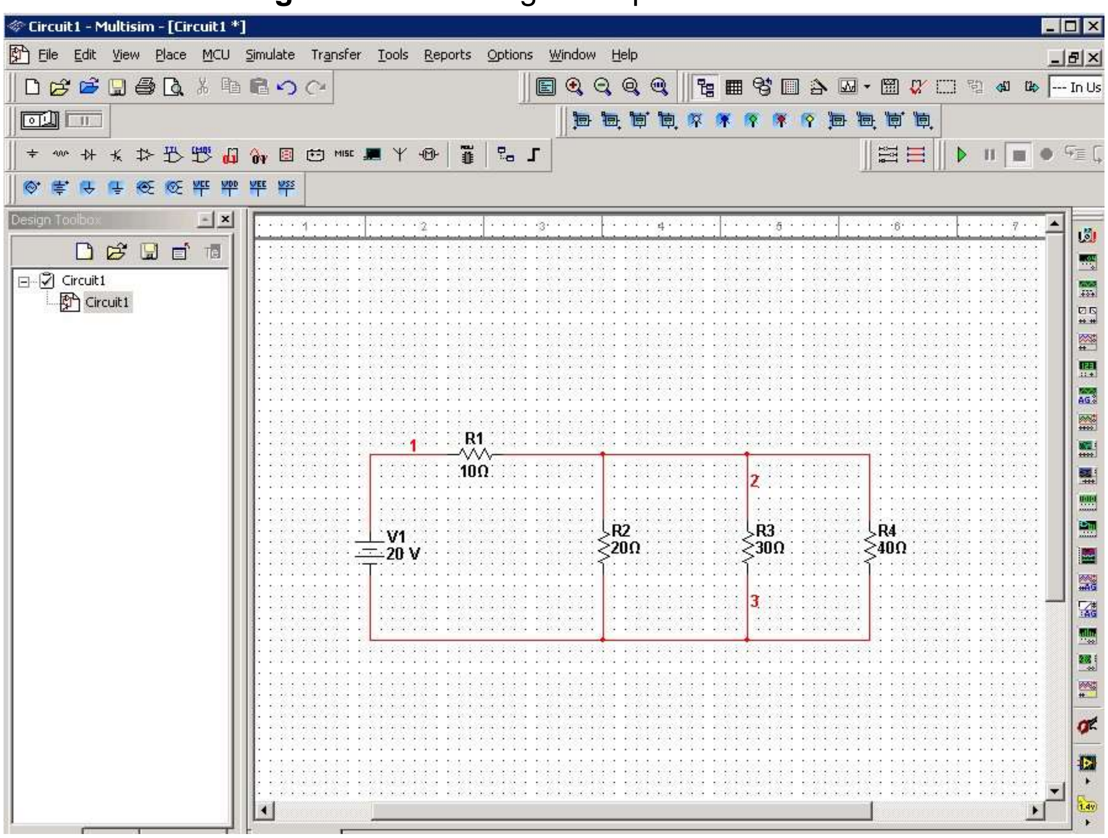


Figure 1.14: Completed circuits

7. Grounding:

All circuits must be grounded before the circuit can be simulated. Click on Ground in the toolbar to ground the circuit. If the circuit is not grounded Multisim will not run the simulation.

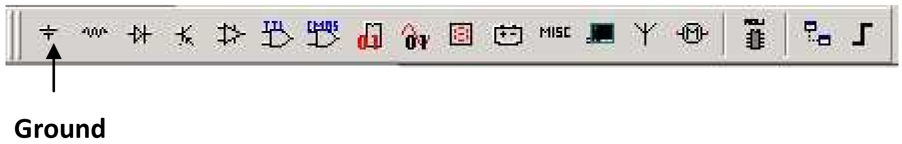


Figure 1.15: Grounding

8. Simulation:

To simulate the completed circuit Click on **Simulate/Run** or **F5.** This feature can also be accessed from the toolbar as shown in the Figure 10 below.

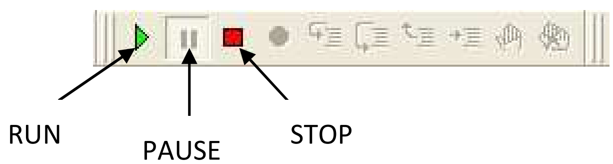


Figure 1.16: Simulation

Analyzing Components

Multisim offers multiple ways to analyze the circuit using virtual instruments. Some of the basic instruments needed for this lab are described below.

1) Multimeter

Use the Multimeter to measure AC or DC voltage or current, and resistance or decibel loss between two nodes in a circuit. To use the Multimeter click on the Multimeter button in the **Instruments** toolbar and click to place its icon on the workspace. Double-click on the icon to open the instrument face, which is used to enter settings and view measurements.

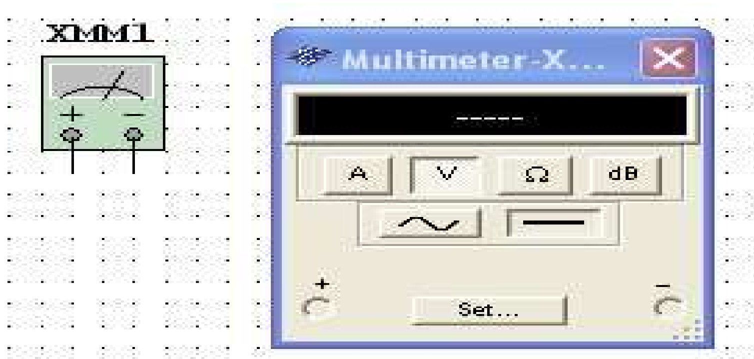


Figure 1.17: Multimeter

To measure Voltage place multimeter in Parallel with the component (Resistor, Voltage etc). To measure Current place the multimeter in series with the component. Reference the Figure 12 and 13.

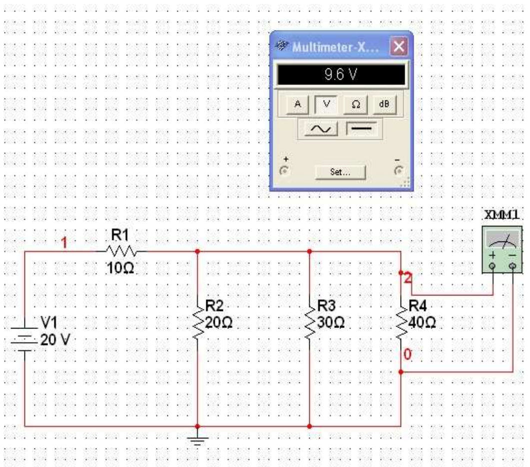


Figure 1.18: Measure Voltage

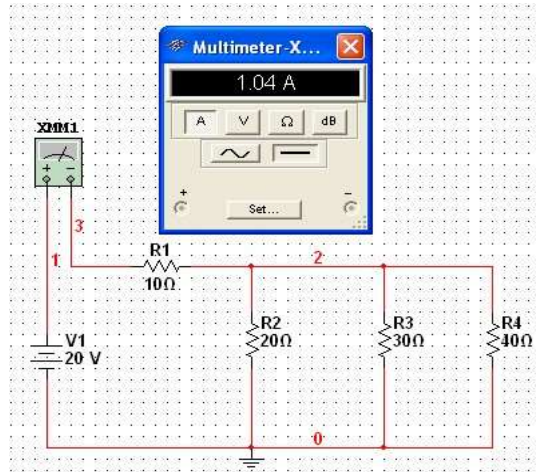


Figure 1.19: Measure Current

5) Voltmeter

The Voltmeter offers advantages over the multimeter for measuring voltage in a circuit. Always connect the voltmeter in parallel with the load. The voltmeter can be found in the measurement toolbar.

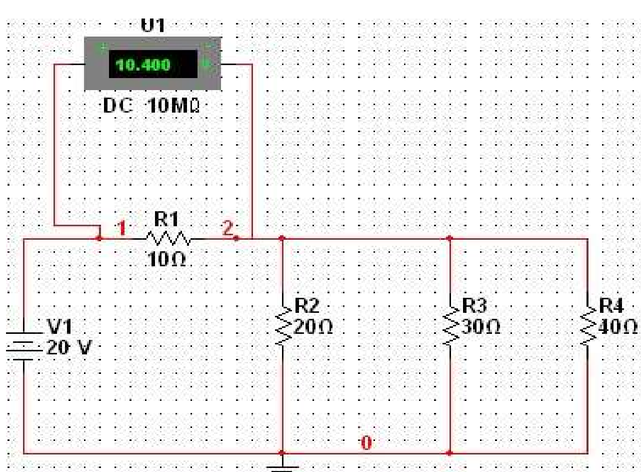


Figure 1.20: Voltmeter

Conclusions & Comments: