# Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Oscilloscopes and Function Generators Worksheet

## Objective

The focus of this worksheet is to introduce Oscilloscopes and Function Generators as powerful test equipment which help in testing designs under test (DUT).

## Discussion Overview

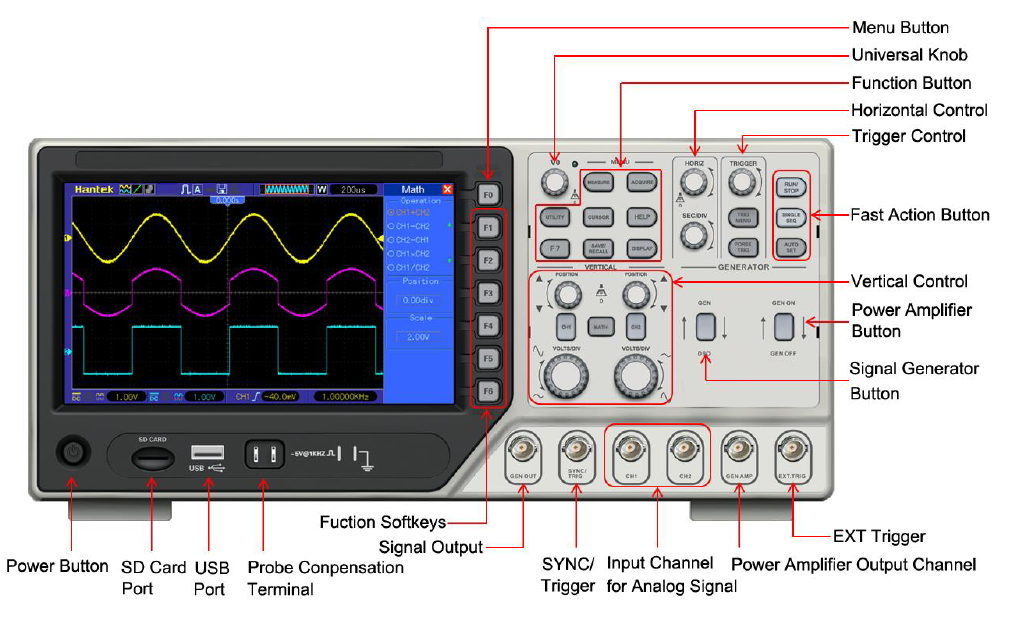
### Oscilloscopes

In electrical engineering, once a circuit is built, testing the design involves various voltage and current measurements to make sure they match predicted or intended values. Some voltage and currents in a circuit do not change appreciably over time. An example of this is the voltage at a power supply such as a battery. For most parts, the voltage across a battery does not change appreciably over time as the circuit operates. These kind of “static” measurements are easily made using a multimeter.

Circuits with voltages and currents that do not change with time, however, are not very terribly interesting circuits. Most circuits that do something interesting have values that change, at times quite rapidly, with time. For such circuits, an oscilloscope is the test equipment of choice. Using an oscilloscope, one can capture the time varying voltage at a node (with respect to ground) as a “real time” waveform. One can observe and measure the change in the voltage over time and determine how fast the voltage is changing.

Next, we will work through some design examples.





## Design Challenge 1

Given a battery of VB volts and an LED, design a circuit to turn the LED on with half its maximum brightness.

Given values:

VB = 9V

LED max turn-on voltage = VLED\_on = 2V

LED max current = ILED\_max = 100ma

Step 1) List of requirements

Step 2) List of known values

Step 3) Type of circuit to use

## 

Step 4 & 5) Write down the equations and solve for the unknowns

At this point, you might want to simulate your design in SPICE to make sure your design has achieved the desired requirements (goals).

Q) What would you do differently if the design had asked to turn on two identical LEDs at the same brightness?

## Design Challenge 2

Given a battery of VB volts and an active circuit with an input A, design a circuit to apply a voltage of VA to the input.



Given values:

VB = 9V

VA\_min = 2.5V

VA\_max = 3.5V

Input A on current = IA\_on = 1ma

Step 1) List of requirements

Step 2) List of known values

Step 3) Type of circuit to use

Step 4 & 5) Write down the equations and solve for the unknowns

At this point, you might want to simulate your design in SPICE to make sure your design has achieved the desired requirements (goals).

Q) What would you do differently if IA\_on was 1a instead of 1ma?

## Design Challenge 3

Given a battery of VB volts, design a circuit to determine the internal series resistance of the battery.

Given values:

VB = 9V

Step 1) List of requirements

Step 2) List of known values

Step 3) Type of circuit to use

Step 4 & 5) Write down the equations and solve for the unknowns

Q) Can this circuit be simulated? If no, why not? If yes, how would you set up the simulation?