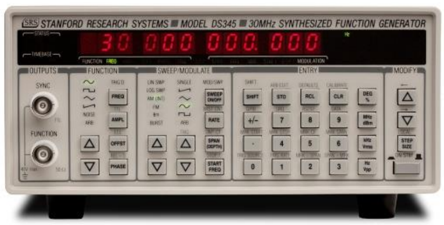
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering
ELEC 1100

Laboratory 1: Instrumentation and Basic Circuits (5%)

A) Objectives

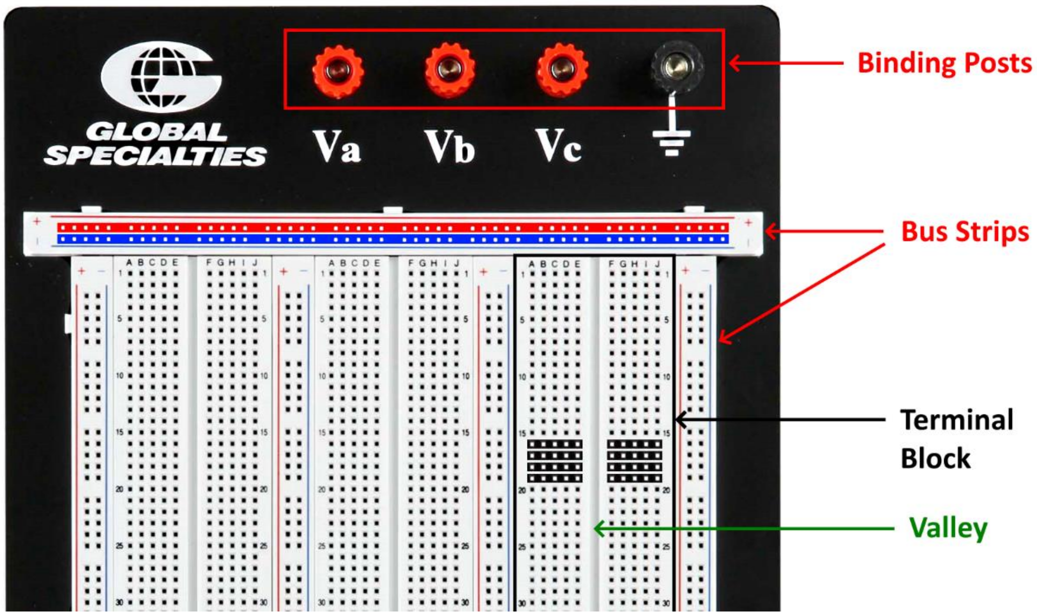
- To familiarize with the equipment in the lab.
- To familiarize with the breadboard circuit design.

B) Equipment in the lab

Item	Required Cables
1) D.C. Power Supply 	1) D.C. Power Supply Cable 
2) Digital Multimeter 	2) Digital Multimeter Probe 
3) Function Generator 	3) Function Generator Probe 
4) Digital Storage Oscilloscope (DSO) 	4) DSO Probe 

5) <u>Breadboard</u>

The breadboard used in our experiment is similar to the figure below. It contains binding posts, bus strips, and terminal blocks. All these parts help you to connect components together to form a complete circuit and allow centralized connections to external power/signal sources and various equipment.



The **binding posts** are usually used to connect to different power sources.

In a **bus strip**, the red (or blue) color bar with dots (illustration only) indicates that all holes in a row are internally connected with metal strips underneath. Any component pins will be electrically connected when they are inserted into the same row. And these two rows of holes are electrically separated and are independent of each other. A bus strip is usually used for power distribution.

Within a **terminal block**, a black color bar with dots (illustration only) indicates that 5 holes in a row are internally connected, with metal strips underneath. Any component pins will be electrically connected when they are inserted into the same row. Rows of 5-hole are electrically separated and are independent of each other. Component connections are mainly done within this block area.

C) Prelab

Read carefully all the information contained in this handout. All the techniques described can be applied to all the experiments in this course.

Every time when measurement or observation is finished, the power supply should be **off** (or disable output). Accidentally large voltage/current changes may cause irreversible damage to your circuits and the breadboard.

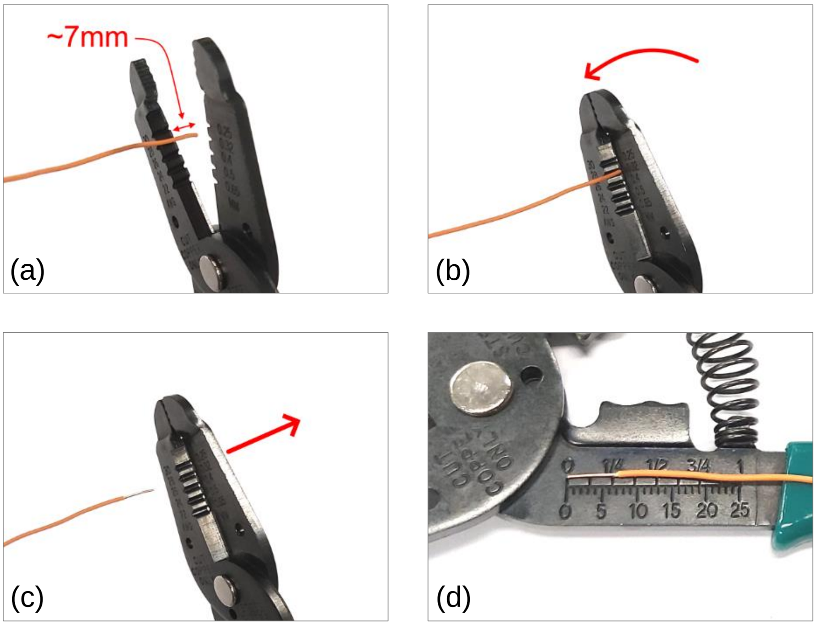
Other instruments can be **on** until all the experiments are finished.

D) Experiment Procedures

Experiment 1: Use of Wire Stripper (~5 mins)

Step 1: Take a little wire from the wire tray. There may be copper openings at either end. However, the openings are usually crook and rusty. They are bad for the breadboard connection and conductivity. Cut off any copper openings at both ends using the wire stripper.

Step 2: There are several stripping holes on the wire stripper. One of the two holes on top shall be good for our provided wires. (a) "Seat" the wire into one side of the proper hole. The cut end shall be **~7mm** from the hole. (b) Slowly press the handles together. (c) Pull the wire stripper towards the cut end of the wire to remove the insulation. (d) Use the scale on stripper to verify the length of the openings.

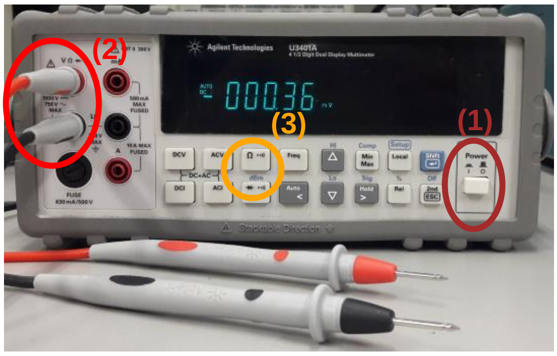


Do not strip too short or too long. A short opening may result in a bad connection; while a long one may result in a short circuit.

Step 3: Prepare 4 to 5 wires for later use.

****** TA Check 1: After practice, demo steps 1-2 to your TA (Each member of a group should demo once).**

Experiment 2: Use of Digital Multimeter (~5 mins)



Step 1: Identity the digital multimeter and switch on.

Step 2: Plug in the multimeter probes to the input terminals as shown. Please match the colors for the common convention.

Step 3: Press [Ω •)))] for measuring resistance.

Step 4: Each student picks an arbitrary resistor.

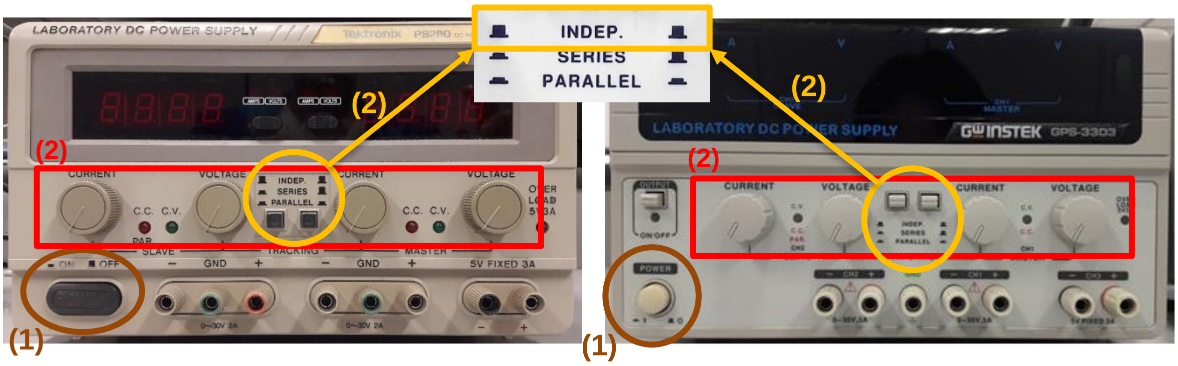
Step 5: Connect the probe leads from the digital multimeter to each end of the resistor. Record the value displayed on the screen.

Step 6: Keep the resistor for Experiment 4.

****** TA Check 2: Demo to your TA. Each member of a group should demo once, using your own resistor.**

Experiment 3: Use of DC Power Supply (~10 mins)

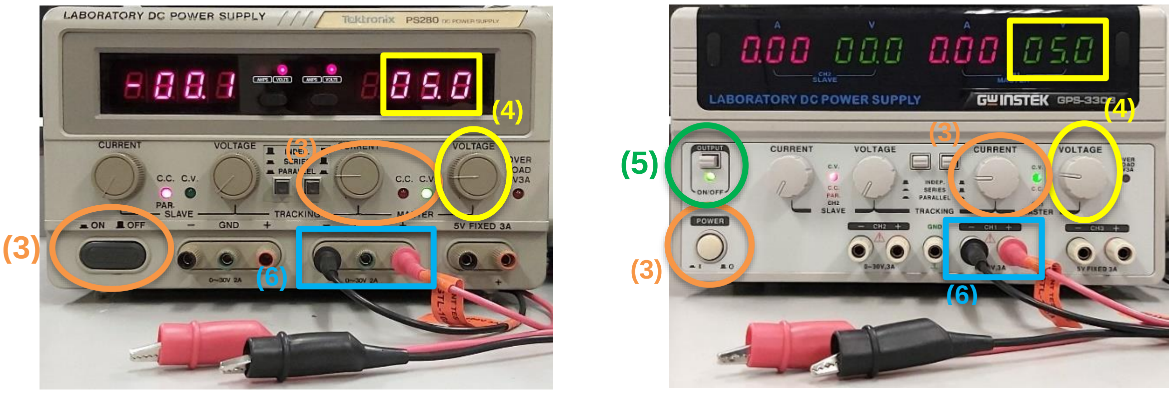
Step 1: Identify the DC power supply. There are two models in the lab as shown. The only difference is that <u>Model 2 has an extra “Output button”</u>. **Switch off** the power supply if it is on.



Model 1: Standard power supply

Model 2: Power supply with extra output button

Step 2: There are two variable output channels, CH1 (Master) and CH2 (Slave), available, each controlled by two circular knobs. <u>Turn all of them fully anti-clockwise</u>. This is a safe practice. Also, in the middle, there are two pushbuttons. Make sure both buttons are NOT pressed down so that two output channels are independent of each other.



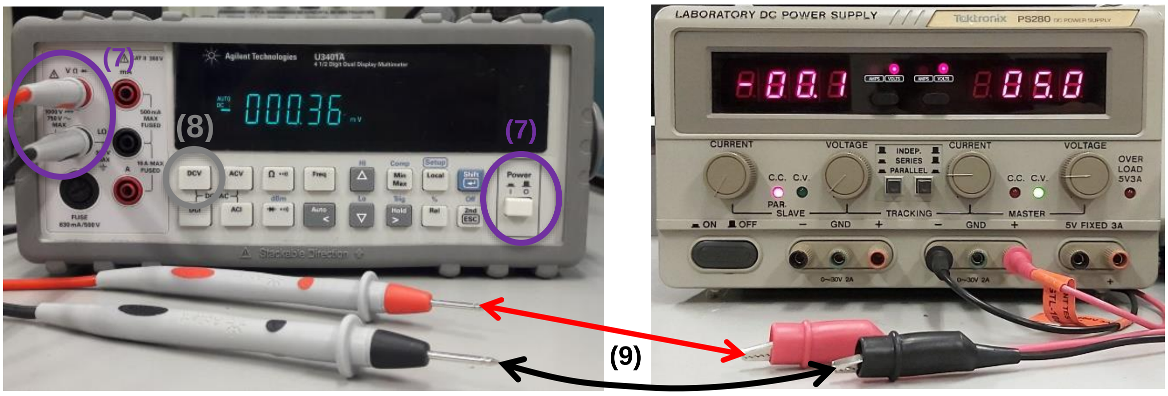
Step 3: Switch on the power supply. Select one variable channel and slowly turn its “CURRENT” knob <u>clockwise</u> until the marking line on the knob is horizontal and the CV light (green) is on. ***CV stands for Constant Voltage***. **This is an important step to protect your circuit by limiting the output current from the power supply.**

Let x be the number represented by the <u>last two digits</u> of your student ID. For example, if your student ID is 12987<u>650</u>, then x = 50.

Step 4: Slowly turn the “VOLTAGE” knob <u>clockwise</u> until the voltage reading is (x/10) as shown in the figure.

Step 5: **(Only for Model 2)** Press the Output button. The green LED should light up.

Step 6: Connect the power supply cable to the output terminals. In common convention, **red** cable to **positive** terminal and **black** cable to the **negative** terminal. *DO NOT connect the GND terminal. We do not use it in all of our experiments.*



Digital Multimeter

Power Supply

Step 7: Switch on the digital multimeter. Plugin the multimeter probes to the input terminals. Please match the colors for the common convention.

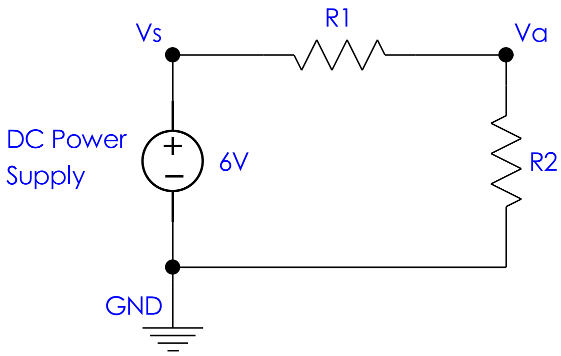
Step 8: Press DCV for measuring DC voltage.

Step 9: Connect the multimeter probes to the power supply cables to check the voltage. You may use the power supply cables to clip the multimeter probe leads.

****** TA Check 3: Demo steps 1–9 to your TA. Each member of a group should demo once, using your own student ID for x.**

Experiment 4: Construct Simple Circuit (~30 mins)

Follow the steps in this experiment to construct and test a simple circuit.



R1 and **R2** are the two resistors that you and your partner used in Experiment 2.

Vs is the name of the node voltage between the power supply and R1.

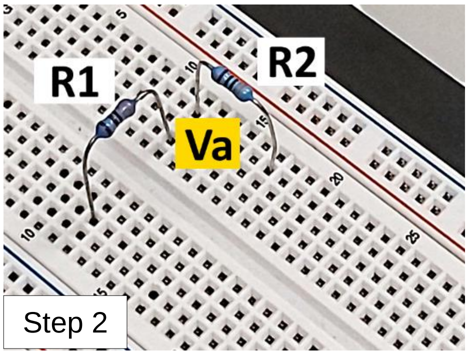
Va is the name of the node voltage between R1 and R2.

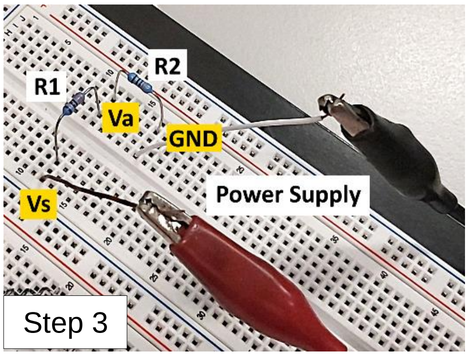
GND indicates 0V at the connection.

Step 1: Assign the two resistors to be R1 and R2 respectively on your own choice and write the values in the summary sheet.

Q1: Write down the assigned resistor values for R1 and R2.

Step 2: Connect R1 and R2 on the breadboard.



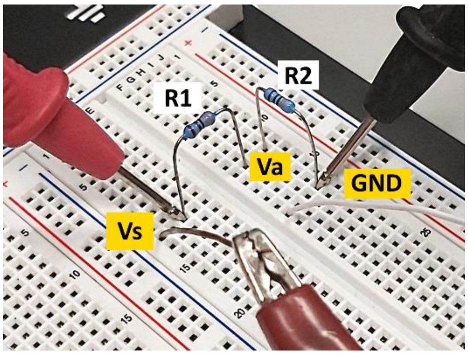


Step 3: Switch off the power supply and turn all the knobs fully anticlockwise as in **Experiment 3**. Connect a variable output channel (Master or Slave) to the resistors accordingly.

Step 4: Generate 6V from the power supply.

Step 5: Set the multimeter to measure DC voltage.

Step 6: Measure Vs and Va and record your results.



As in the photo, for voltage measurement, ***the black probe lead should always touch at the GND connection*** *while the red probe can touch at wherever connection you want to measure.*

Also, the probe lead should touch at the pin bottom of the resistor (or other components) for a stable contact.

NEVER insert the probe lead into the breadboard hole otherwise the hole and the metal strip underneath would be damaged.

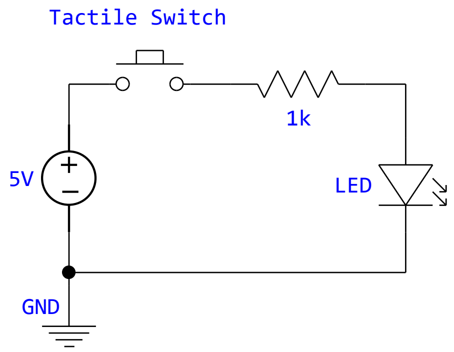
Q2: What are the values of Vs and Va?

Q3: Calculate the voltage ratio $\frac{Va}{Vs}$ and resistance ratio $\frac{R2}{R1+R2}$ see if they match.

<u>Experiment 5: Capacitor Effect in Circuit (~15 mins)</u>

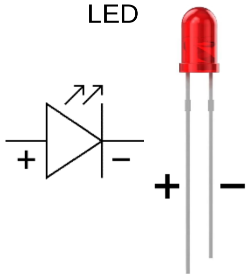
In this experiment, we will study the effect of a capacitor in a circuit.

Step 1: Construct the following circuit on the breadboard.



Tactile Switch

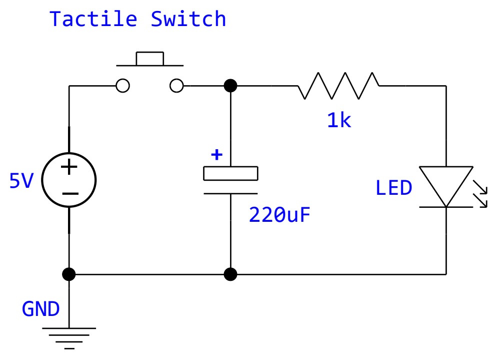
LED



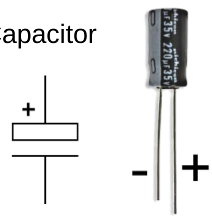
Step 2: While observing the LED, press and release the tactile switch.

Q4: What is the purpose of using the resistor in the circuit?

Step 3: Add a capacitor to the circuit as below.



Capacitor



Step 4: While observing the LED, press and release the tactile switch.

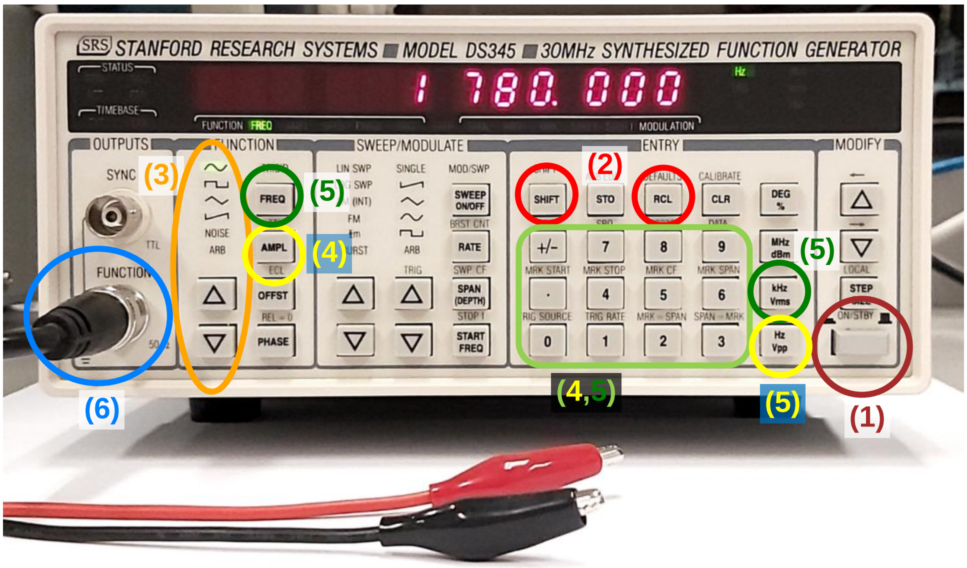
Q5: Describe what happens after adding the capacitor. Explain briefly why this happens (explain the function of the capacitor).

****** TA Check 4: Demo to your TA about the result of Step 4.**

Experiment 6: Use of Function Generator and DSO (~20 mins)

Part A

Step 1: Identify the Function Generator and switch on.



Step 2: Reset the function generator by pressing SHIFT and then RCL to remove any hidden user settings.

Step 3: Set the function to **Sine Wave** ∼ , using △ and ▽ buttons if necessary.

Step 4: Set the amplitude to **1.5V**. Press AMPL . Key in value 1.5 using the number buttons. Press unit Hz Vpp .

Let x be the number represented by the <u>last two digits</u> of your student ID. For example, if your student ID is 123456<u>78</u>, then x = 78.

Step 5: Set the frequency to **(1+x/100)** kHz. Press FREQ . Key in the value (for example, if x = 78, key in 1.78). Press unit kHz Vrms .

Step 6: Connect the Generator probe (shown on page 1) to the **FUNCTION** output of the function generator. Do **NOT** mistake the Generator Probe with the DSO Probe. Note that the red clip is positive and the <u>black</u> clip is <u>negative</u>.

Part B

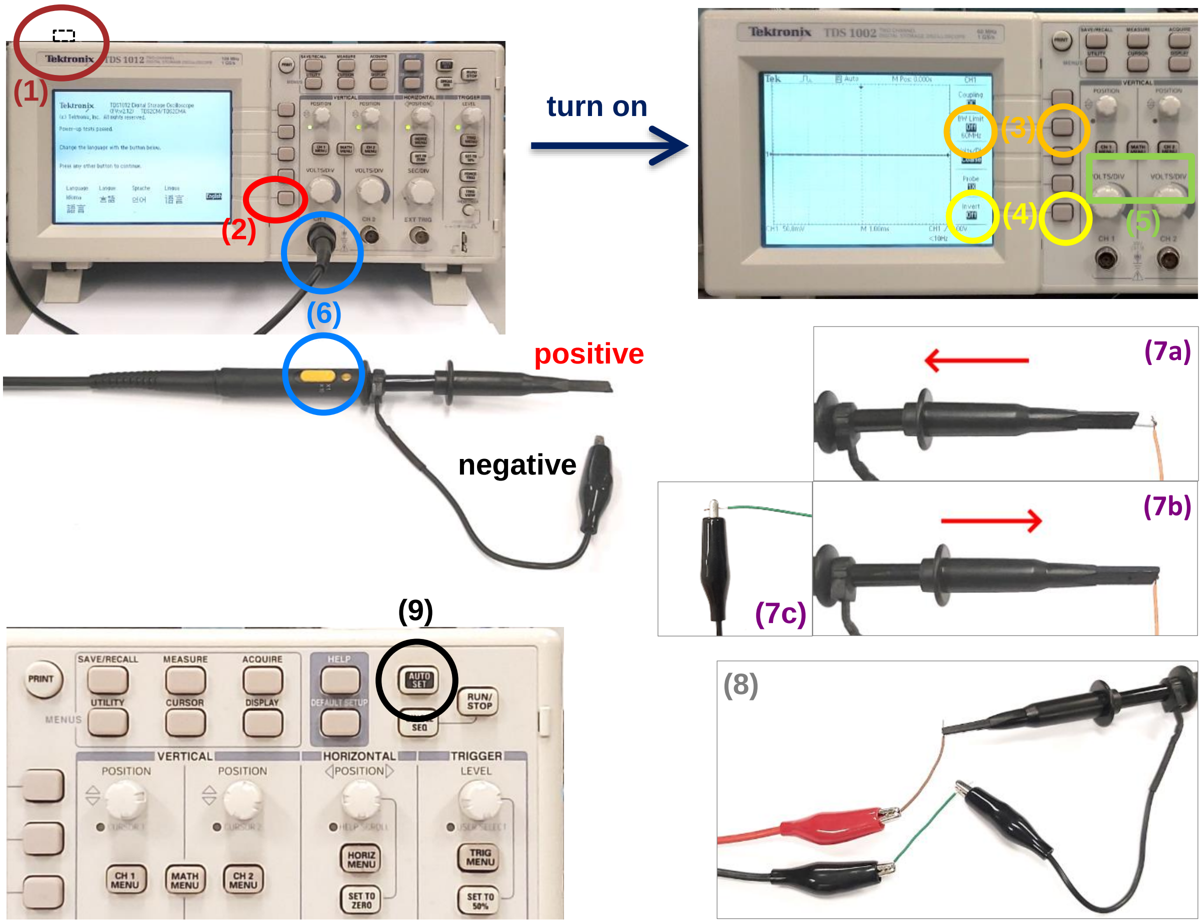
Step 1: Identify the DSO and switch on.

Step 2: Change the language if necessary. If no change is needed, press any other button.

Step 3: Channel Coupling should be set to **DC**. If not, toggle with the button next to it until it shows **DC**.

Step 4: Channel Probe should be set to **1X**. If not, toggle with the button next to it until it shows **1X**.

Step 5: If you would like to set for the other channel, press that channel **MENU** button. Then repeat steps 3 & 4.



Step 6: Connect the DSO Probe head to the oscilloscope and <u>set the probe to **1X**</u>.

Step 7: Get two wires prepared from Experiment 1. The probe-like structure is the positive terminal, while the small clip is <u>negative</u>. (a) Pull back the cap of the positive terminal to expose the hook. Take a wire and "seat" one end into the hook. (b) Release the cap. (c) Take another wire and clip one end at the negative terminal.

Step 8: Connect the two unattached ends of the two wires to the Generator probe, positive to positive, negative to negative.

Step 9: Press **AUTO SET** button and observe the waveform displayed on the screen.

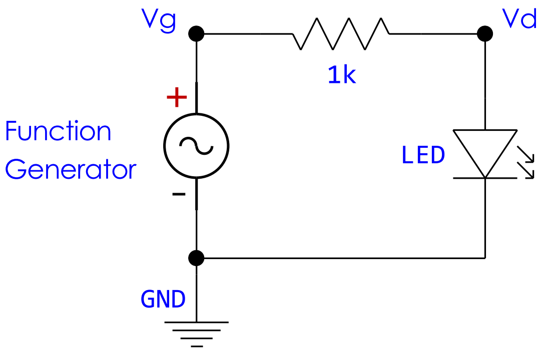
Q6: From the DSO (left bottom), what is the value of each division on the voltage axis?

Q7: From the DSO (middle bottom), what is the value of each division on the time axis?

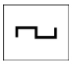
Q8: From the DSO, what is the period (time for the signal to repeat) of the signal?

****** TA Check 5: After practice, demo Parts A and B to your TA. Each member of a group should demo once, using your own student ID for x.**

Experiment 7: Use Function Generator as AC Voltage Source (~30 mins)



Step 1: Construct the circuit on the breadboard.

Step 2: Set the function to **Square Wave** , the frequency to **100 Hz**, and the amplitude to **5V**.

Step 3: The LED should light up.

****** TA Check 6: Show your TA that the LED light up.**

Step 4: Gradually reduce the frequency of the square wave so that you can just see the LED starts blinking.

Q9: What is the lowest frequency that you need to use to **avoid** the LED from blinking? (Just give a rough number)

We now use DSO to observe the waveforms at Vg and Vd.

Step 5: Connect two DSO probes to CH1 and CH2 respectively. Remember to set <u>both probes</u> to 1X.

Step 6: Use CH1 to observe the output waveform of the function generator at Vg. Use CH2 to observe the signal at Vd which is the voltage across the LED.

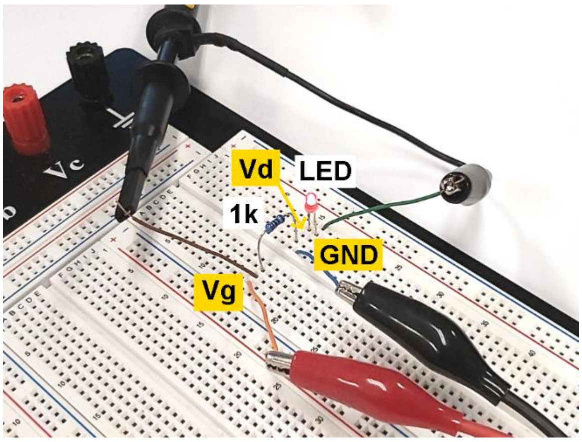


Photo shows how to measure Vg.

Similar technique shall be applied to measure Vd.

Note that in any measurement, the clip (negative terminal) of the DSO probe should always connect to GND of a circuit.

Q10: Determine the voltage drop across the resistor from the waveforms?

Remember to clean up your bench! A messy table will cost 3 points!