ESC201 Introduction to Electronics Lab 1 Handout for Lab Experiments
Familiarization with Laboratory Instruments

The aim of the experiment is to familiarize yourself with two instruments in the basic electronics laboratory. A Function Generator (FG) produces voltage signal and Digital Storage Oscilloscope (DSO) measures it. You will learn the operation of these instruments through experimentation with some simple circuits.

Experiment 1: Operation of the FG and the DSO (*2 × 5 = 10 marks*)

1. Connect the output of the FG to the CH-1 of the DSO using the co-axial cables and the breadboard. Choose sine function in the FG and adjust the controls to get a 5 V $sin(\omega t)$ with 1 kHz frequency on the FG. Note that the peak-to-peak voltage of the sine wave will be 10V. Obtain a clearly visible and stable waveform. You may need to adjust the horizontal and vertical scales (for the time and voltage axis, respectively) and the trigger level control of the DSO to get a clearly visible and stable display on the DSO. If you are unable to get a proper display of the waveform on the DSO, you can press the 'Default' or 'Auto Scale' button. Plot the waveform and mark the axes properly (only a freehand drawing of the waveform is required).
2. Measure manually the maximum, minimum, and the peak-to-peak value of the sine wave using cursors. Note down the values on your lab report.
3. Choose a time/div on the DSO such that the sine wave is well expanded and only 2 to 3 full oscillations are visible on the screen. Measure the time period of the sine wave as accurately as you can using cursors and note it down. Also, check the corresponding frequency reading on the DSO and write it down.
4. Use the measure function of DSO to measure the maximum, minimum, peak-to-peak value and frequency of the waveform. Note down the values obtained from the measure function. Compare these values with the ones those you have measured manually using cursors, and comment.
5. Write down the maximum, minimum and time period of the sine wave on the axes of the plotted waveform based on the best measurement results obtained. (Plotting means not only sketching it but also indicating all relevant features with quantitative results.)

Experiment 2: Triggering of the Signal on the DSO (*2 × 5 = 10 marks*)

1. Connect the output of the FG to the CH-1 of the DSO using the co-axial cables and the breadboard. Choose sine function in the FG and adjust the controls to get a 5 V $sin(\omega t)$ with 1 kHz frequency on the FG. Adjust the time/div on the DSO such that the sine wave is well expanded and only one complete oscillation is visible on the screen. Rotate the small knob in the Horizontal section to change the zero of the time axis and study the effect on the waveform displayed. Now, rotate the trigger knob and study the effect of level control of the trigger level on the waveform displayed. Write down your observations and explain.
2. Keep the time/div on the DSO unchanged, and change the slope control of trigger to alternating edge and study the effect. Write down your observation, plot the waveform displayed on the DSO and explain.
3. Keep the time/div on the DSO unchanged, and change the slope control of trigger back to rising edge, then to falling edge and vice versa, and study the effect of slope control on the waveform displayed. Write down your observation and explain.
4. Keep the slope control of the trigger to rising edge and the trigger level in the centre middle by adjusting the time axis and trigger level. Change the frequency to 1 Hz and readjust the time/div on the DSO display such that the sine wave is well expanded and only one complete oscillation is visible on the screen. Observe for a minute, and then write down your observation and explain.
5. Now, for the 1 Hz sine waveform obtained above, change the trigger mode from auto to normal. Observe for a minute, and see if there is any change in the observation. Write down your observation and explain. <u>Change the trigger mode to auto again for the rest of the experiments on the next page.</u>

Experiment 3: Advanced Operation of the FG and the DSO (*2 × 5 = 10 marks*)

Choose 'Pulse Mode' and set the FG to obtain a square wave of 500 Hz frequency going from 0 V to 7 V. Display the FG output on the CH-1 of the DSO. Adjust the vertical position of the display on the DSO such that the 0 V level is at the middle of the display. Set the voltage level of the waveform using the 'Offset' knob in pulled out position and 'Ampl' knob of the FG such that the low level of the pulse is at 0 V and the high level is at 7 V. Check that both the DSO CH-1 Coupling mode and the Trigger Coupling mode are set to DC, and obtain a stable display by moving the trigger level appropriately.

1. Observe, measure, and plot the waveform. Now, change the Trigger Coupling mode from DC to AC, and observe the effect of this change by rotating the Trigger knob. Note down your observation.
2. Set the Trigger Coupling mode to DC, and change the DSO CH-1 Coupling mode from DC to AC. Observe any change in the display of the waveform, and note it down along with a plot of the waveform.
3. Set both the Trigger Coupling mode and the CH-1 Coupling mode to DC. Turn off the offset by pushing the 'Offset' button of the FG and observe any change in the display and note it down along with a plot.
4. Using the Duty cycle control facility, adjust the wave to have 0.5 ms high level and 1.5 ms low level, and note down the duty cycle. Observe and measure the waveform, and plot it. Using the Duty cycle control facility, find the minimum and maximum duty cycles one can have from the FG, and note down the results.
5. Take output from the TTL/CMOS socket of the FG. Press 'Shift' followed by 'TTL' button to get TTL output keeping the TTL/CMOS knob in pushed in position. Observe, measure and plot the TTL output. Keeping the TTL/CMOS knob in pulled out position, get the CMOS output. Get a CMOS output signal of 7 V amplitude, 1 kHz frequency and 25% duty cycle. Observe, measure and plot the CMOS output.

Experiment 4: XY Plot using the DSO (*2 × 5 = 10 marks*)

Note: Before observing the XY plot, observe both the waveforms in CH-1 and CH-2 of the DSO in the Normal mode and properly trigger the waveforms. Put the DSO in the XY mode with acquire mode in high resolution.

1. Adjust the FG to get a 5 V *sin*(ωt) of 1 kHz frequency. Put the CH-1 and CH-2 inputs of the DSO to the ground of FG. Put the DSO in the XY mode. See the positions of arrows on the axis of the screen and the dot, and adjust the positions so that the dot displayed is located at the centre. Note down your observation.
2. Now connect both CH-1 and CH-2 of the DSO to the FG output and choose DC modes for both CH-1 and CH-2 as well as the same volt/div for both channels. Observe the display in the XY mode, measure using cursors and plot the result. Invert the CH-2 waveform only (but not CH-1) using the Invert operation on the DSO and note down how the XY plot has changed. Now, invert both CH-1 and CH-2 waveforms and write down how the XY plot has changed. <u>Set both the channels to be non-inverting again for exp. below</u>.
3. Set up a simple potential divider circuit using two 10 kΩ resistors on the breadboard as shown in Fig. E4a, i.e., take $R_1 = R_2 = 10$ kΩ. Now, connect CH-1 (taken as X) to the FG output and CH-2 (taken as Y) to the potential divider output. Observe the display in the XY mode, measure and plot the result.
4. Now, keep $R_1 = 10$ kΩ and $R_2 = 1$ kΩ. Observe the display in the XY mode, measure and plot the result.
5. Set up the circuit shown in Fig. E4b on the breadboard using a 10 kΩ potentiometer (which itself is a simple potential divider circuit). Connect CH-1 of the DSO (taken as X) to the FG output and CH-2 of the DSO (taken as Y) to the potential divider output, i.e., the middle wire of the potentiometer. Observe the CH-2 waveform in Normal mode, see how the CH-2 output is changing if the potentiometer knob is varied, and note down the results. Now, observe the display in the XY mode, vary the potentiometer knob and obtain XY plots for 3 different positions of the potentiometer knob including two extreme positions.

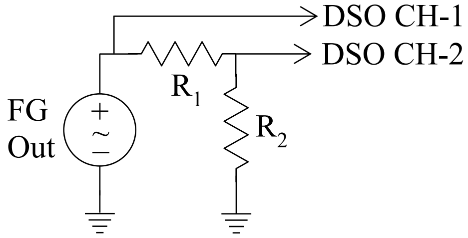

Figure E4a

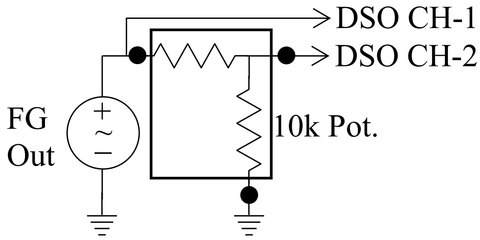

Figure E4b