Analog Electronic Circuits Lab (EC2.103, Spring 2022)

TAs: Adithya, Bharadwaj, Pavani, Shreshtha, Anis

(Instructor: Prof. Abhishek Srivastava, CVEST, IIIT Hyderabad)

Instructions:

1. Systematically record your observations in the lab book
2. Save results in USB or take pictures
3. Make meaningful tables to summarize your findings and show it to the instructor(s) during the lab session only
4. Bring your calculators and DMM (if available)
5. Handle equipments carefully and report in case of any incidence
6. Enjoy your time in lab and strengthen your understanding about circuits

Experiment-1
RC Circuits and diode characterization

1. Know your equipment

a) Bread-board/power-supply/multimeter
Familiarize yourself with these modules.

b) Oscilloscope and function generator
We will use *Keysight EDUX1052G Digital Storage Oscilloscope (DSO)* in our experiments. It has 2 oscilloscope channels and 1 waveform generator in built. For complete functionality refer to the User guide (shared on moodle): Keysight InfiniiVision 1200 X-Series and EDUX1052A/G Oscilloscopes.

i. Read the RC specifications of oscilloscope probes and channel on the equipment

ii. Plot Demo signal available on DSO in one of the channels and report signal parameters (shape, amplitude and frequency)

iii. Generate different types of signals using 'Wave Gen' option and observe it on DSO channels. Play with 1X and 10X modes on the probe tip and DSO settings and verify that amplitude of $V_{OSC} = \frac{OSCfactor}{Probefactor} \times V_{in}$.

iv. Generate 10 kHz sine wave with $1V_{pp}$ amplitude and observe its spectrum using FFT feature on DSO.

v. Now change the wave type from sine to square and observe spectrum. Do you see harmonics (multiple of fundamentals)? Can you reduce the strengths of harmonics using simple RC low pass configuration discussed in lecture? Suggest values of R and C. Ask for those components and realize the filter and show that harmonics strengths reduce in FFT spectrum. (Record in lab book and show)

2. Estimate the effective probe-capacitance (Record in lab book and show)

As shown in Fig. 1, You are given $R = 1M\Omega$ and $C = 10\ pF$. Plot input and output using two channels of DSO and measure the time constant (τ_{meas}) of the circuit (use probes/DSO in **10x mode**). Does it match with the calculated (theoretical) value of the time constant (τ_{theo})? What could be the cause (extra cap due to probe/wires/bread-board (C_{probe})). Estimate the value of C_{probe}. Verify your estimation with $C = 100\ pF$ or $C = 27\ pF$. Make a table clearly showing R, C, C_{probe}, τ_{theo}, τ_{meas}. Draw/attach waveforms. *(Hint: You can either use switch or a pulse source, use cursor facility in DSO and clearly mark the values).*

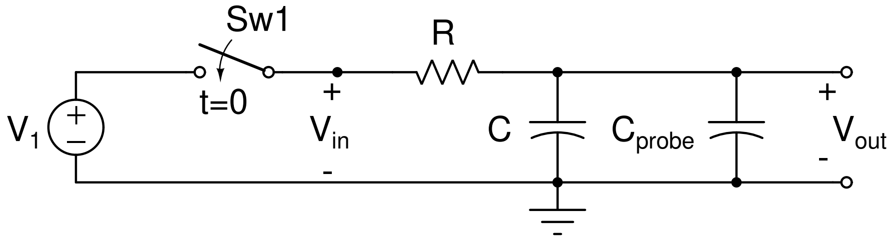

Figure 1

3. **Two capacitor experiment** (Record in lab book and show)
In this experiment we will be observing the switching behaviour (charging and dis-charging) of capacitors for the two capacitor network discussed during lecture. For this we will use the circuit arrangement shown in Fig. 2.

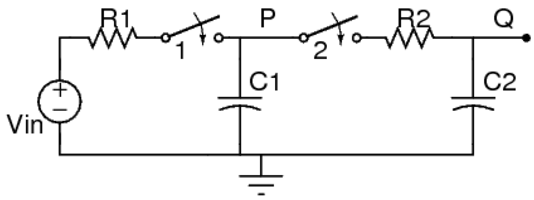

Figure 2

   (a) Connect the circuit as shown in Fig. 2 (*Use push buttons*). Choose the values of R and C appropriately so that the time it takes for the capacitors to either charge or discharge($5{*}\tau$) is of the order of 100 ms to be able to observe it on the oscilloscope. For example, Set $C_1 = C_2 = 1\ \mu F$ and $R_1 = R_2 = 100$ KΩ.
   (b) Apply a DC supply voltage of 1V with the help of the function generator integrated in the oscilloscope('Wave Gen').
   (c) Initially, switch 1 is closed (*push button is kept pressed*) and switch 2 is opened, which allows the capacitor C_1 to charge to the supply voltage(1V). To observe that C_1 is charged/charging, at node P as shown in Figure 2, we place the probe and set the time scale in the order of 100 ms.
   (d) When C_1 is completely charged, open switch 1 and close switch 2, and observe the voltage across nodes P and Q using probes in the oscilloscope. (*Set the time scale in the order of 100 ms. Use Run/Stop button on DSO to capture your plot*)
   (e) Note the observations on how the voltages change as time elapses and try to give intuitive explanations for the same.
   (f) Now, change the values of $R_2 = 10$ KΩ and observe the changes in the plot on oscilloscope. Report the time it takes to reach V_P and V_Q to its final values for the two values of R_2.
   (*Note: Make sure that you discharge the capacitors C1 and C2 before each trial of experiment to get proper plots, as they tend to hold on to the charge.*)

4. **Diode Characteristics** (Record in lab book and show)
Connect the diode in forward bias as shown in Fig. 3 on the breadboard. (Refer to figure 4 for biasing). Apply a sinusoidal signal as the input (V_{in}), with amplitude 1V, using the function generator 'WavGen'.

   (a) Observe the output signal ($V_{out}(t)$). What can you infer from this? Note down your input output plots/observations.

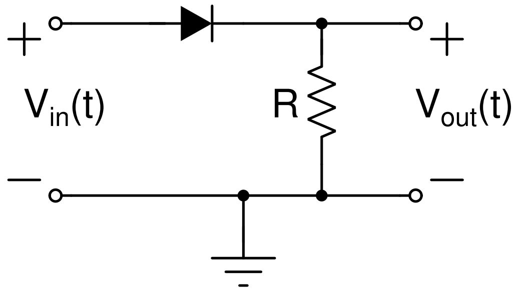

Figure 3: Forward Biased

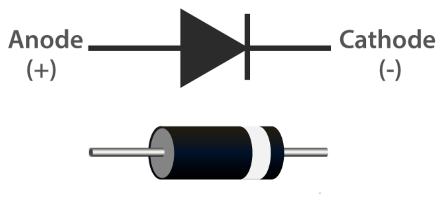

Figure 4

(b) Plot the I-V characteristics on the oscilloscope using the X-Y mode by pressing the **'Aquire'** button (XY mode plots V_{out} vs V_{in}, where V_{out} is proportional to the current (I_D) through the diode.)

(c) Find the cut-in voltage from the I-V characteristic plot using the cursor options.

(d) Obtain the current at this position by dividing V_{out} with R.

(e) Connect the diode in reverse bias and observe the output. What do you infer from the output?

(f) Plot the I-V characteristics on the oscilloscope. Observe the I-V characteristics in both forward and backward bias configurations and note down your observations.