



**EE 230 - Analog Lab**  
Wadhvani Electronics Laboratory  
Electrical Engineering IIT Bombay

Lab:1

---

**Instructions:**

- Write down all your observations in notebook.
- Verify your calculations with your respective TA.

**Objectives:**

- Familiarization with Lab Equipment's and basics of probing the circuit.
  - Plot the time and frequency responses of the RC circuit.
  - Familiarizing with diode-based circuit.
  - Familiarizing with Operational Amplifier-based circuit.
- 

**1. Time response of the RC circuits**

Fig.[ 1] is a simple RC low pass filter.  $R_1 = 1K\Omega$  and  $C_1 = 100nF$ .

- (a) Find the transient response of this RC circuit by applying a square wave ( $V_{in1}$ ) of  $5 V_{pp}$  with a period of 2 milliseconds and 2.5 V DC offset. Determine the time constant (Using Cursor). Time constant is defined as the time taken by output voltage to rise by 63.2% of the maximum output voltage. Explain your observations (waveforms).

Note: While measuring using cursor ensure that the part of waveform which is to be observed/measured is adequately zoomed-in in DSO to get accurate readings.

- (b) Determine the bandwidth (in Hz) of the circuit. Bandwidth (in rad/s) is defined as the reciprocal of the time constant. Compare the calculated and measured bandwidth. what is the reason behind the difference between theoretical and practical values?
- (c) Determine the rise time and the fall time using 'Cursor' on DSO. Rise(Fall) time is defined as the time taken for the signal to reach from 10-90% (90-10%) of its peak-to-peak value (Zoom in and measure). Repeat the same measurements using the 'Measure' functionality on DSO. Compare the results got from cursor and measure utility.

**2. Frequency response of the RC circuits**

- (a) Determine amplitude-frequency response (magnitude Bode plot) of the Fig.[ 1] RC Network by applying sinusoidal input ( $1 V_{pp}$ ) and measuring  $V_{out_{pp}}$  at different input frequencies(start from 5 Hz and take more readings until 3 kHz and go to 1 MHz in a step of decades). Note-down readings in tabular format in your notebook. Draw a rough frequency response plot in your notebook.

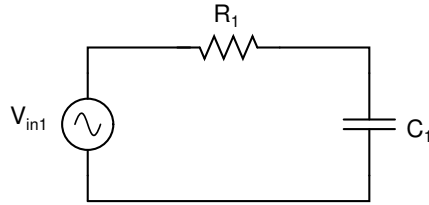


Figure 1: RC Low Pass Filter

- (b) Determine the bandwidth of the circuit from amplitude-frequency response. Bandwidth is the frequency range in which the output of a circuit reaches  $\frac{1}{\sqrt{2}}$  times the amplitude of the input signal, often corresponding to a -3 dB reduction in output amplitude.
- (c) Compare measured bandwidth with the bandwidth calculated from time domain response. Explain your observations.

### 3. Basics of probing the circuit

Fig.[ 2] is a simple potential divider circuit. Probing the circuit means measuring/acquiring electrical signals on oscilloscope. Below are the experiments to demonstrate correct way of probing the circuit

- (a) Take  $V_{dd} = +15$  V,  $V_{ss} = -15$  V from DC Power Supply and all resistors of  $10K\Omega$ . Measure the voltage across R3 resistor using channel 1 of DSO. Compare with the expected value.
- (b) Measure the voltage across the R2 resistor using channel 2 of DSO (without removing channel-1 connected across R3 resistor). Compare measured results with the expected result. Explain the cause of error.
- (c) To avoid the above cause of the error, which instrument will you use to probe the circuit?
- (d) Remove both DSO channels from the circuit and instead of taking VDD and VSS from dc power supply, apply sinusoidal input of  $5 V_{pp}$ , 4.7 KHz from AFG across the potential divider. Measure the voltage waveform across R2. Compare the results with the expected waveform. Explain your observation.



Figure 2: Potential divider circuit

### 4. Half wave Rectifier

- (a) The half wave rectifier circuit shown in the figure [ 3] with  $R = 22k\Omega$  and 1N4007 diodes. Apply a sinusoidal input with  $4V_{pp}$  and frequency  $1kHz$ . Plot  $V_i$  and  $V_o$  with respect to time on DSO.

- (b) Explain the reason behind the reduction in the peak amplitude between the input and the output voltage.
- (c) Now, change the polarity of the diode and Explain your observations. Draw the  $V_i$  and  $V_o$  waveform in your notebook.

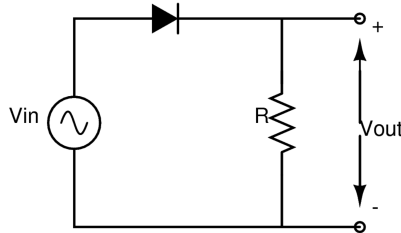


Figure 3: Half wave rectifier

### 5. OpAmp based Negative feedback circuits - Non Inverting Amplifier

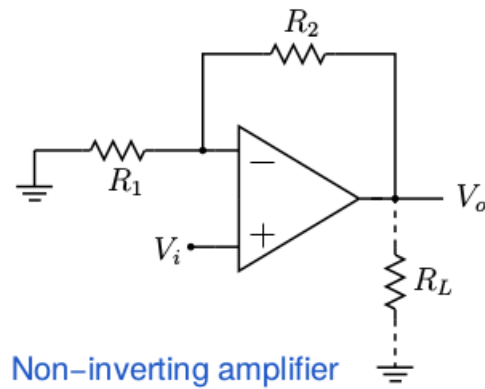


Figure 4: Non-Inverting amplifier

- (a) The inverting amplifier circuit shown in the figure [ 4] with  $R_1 = 1k\Omega$ ,  $R_2 = 10k\Omega$ . Apply a sinusoidal input with a peak of  $0.1V$  and frequency  $1kHz$ . Apply the supply voltage of  $\pm 15V$ . Plot  $V_i$  and  $V_o$  with respect to time. Don't connect  $R_L$  explicitly, DSO itself will act as a load while measuring the output.
- (b) Now, change the input amplitude from  $0.1V$  to  $2V$  and observe the output waveform. Explain what happens to output voltage after a particular value of input voltage.