AEC LAB REPORT-1

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Experiment-1:

RC Circuits and diode characterization

1. Know your equipment:

a)First we familiarize ourselves with bread board, power supply and multimeter.

b)

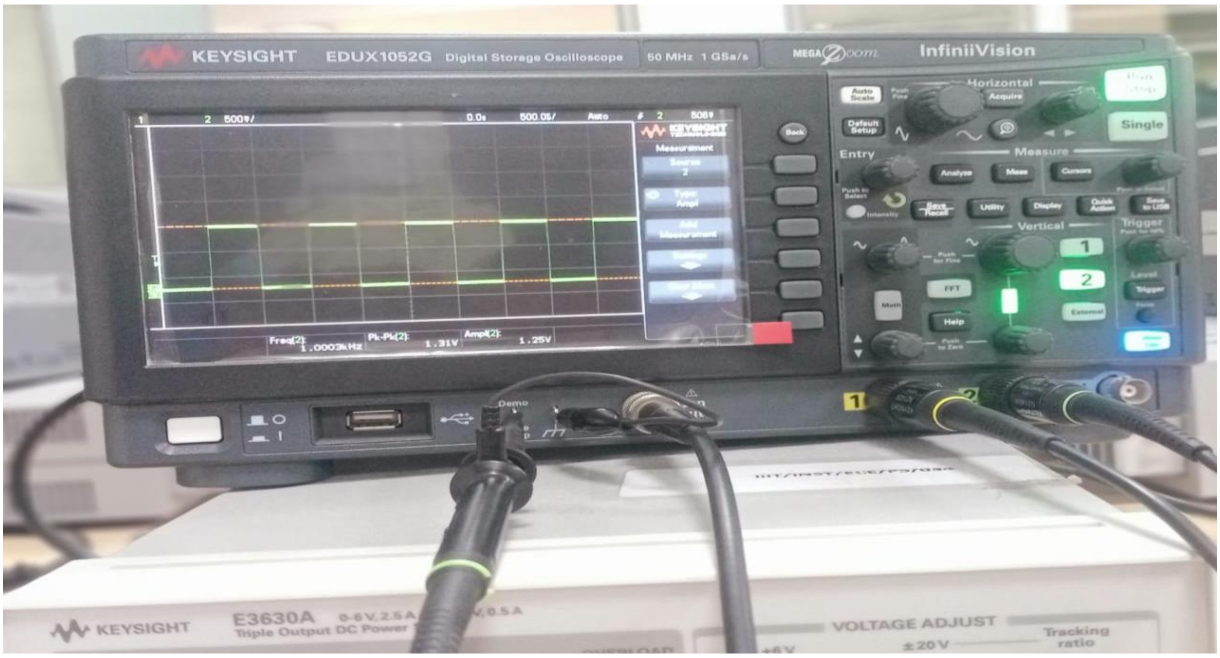
i. Now read the RC specifications of oscilloscope probes and channel on the equipment

Probe specifications:-

10:1 75MHz
10M ohm and 15pF

1:1
1M ohm and 100pF

ii. Plot Demo signal available on DSO in one of the channels and
shape of signal =square wave,
amplitude=1.31v(peak to peak),
frequency=1000.2 Hz

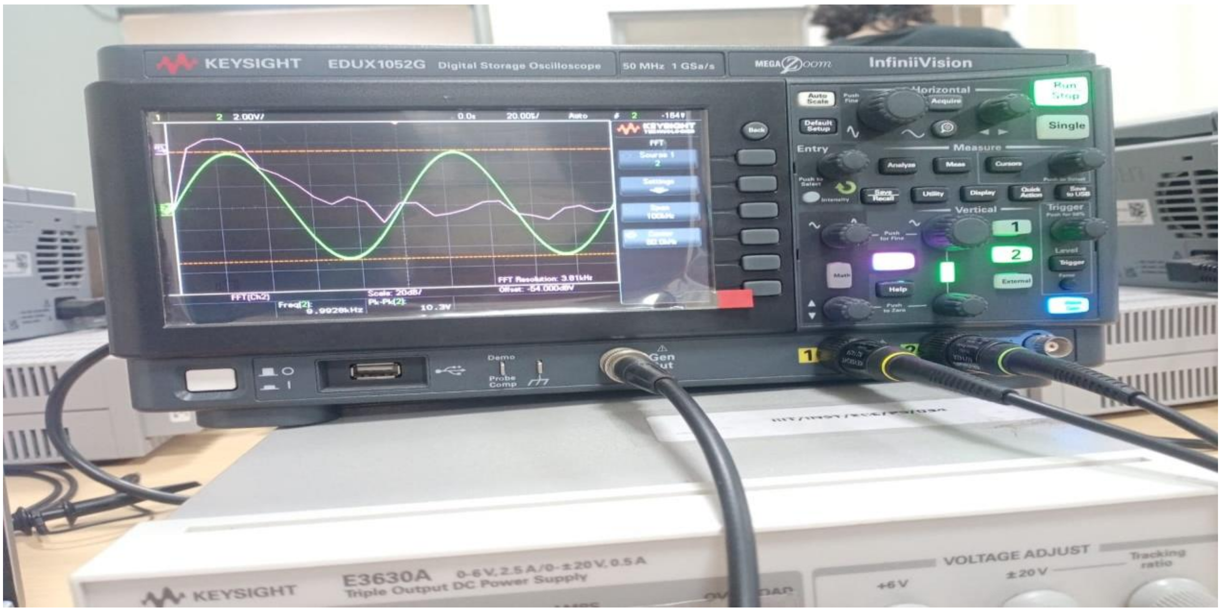


iii. now we generate a signal and specifications are below:

Type of signal	Amp(Vin)	Frequency	Probe factor	OSC factor	V(OSC) (mv) (measured)	VOSC = (OSCfactor / Probefactor) × Vin.
sinusoidal	4v	10.002kHz	10	10	4.14	4
sinusoidal	4v	10.002kHz	10	5	2.07	2
sinusoidal	4v	10.002kHz	1	10	41.4	40
sinusoidal	4v	10.002kHz	1	5	20.7	20
sinusoidal	4v	10.002kHz	1	2	8.3	8

Then generate Sine wave of frequency 10 KHz, span=100kHz, centre=50KHz and observe the spectrum using FFT.

First Harmonic(x1)=10kHz
Second Harmonic(x2)=20kHz
Third Harmonic(x3)=30kHz
We are getting frequencies in form of f,2f,3f…..



iv. Generate Square wave of frequency=10kHz, span frequency=100kHz , centre frequency=50KHzand observe the Frequency Spectrum.

Take R=47ohm and C=47nf.

Then perform the same by taking input as square wave:

First Harmonic(x1)=10kHz
second Harmonic(x3)=30.2kHz
third Harmonic(x5)=50kHz
fourth Harmonic(x5)=70kHz
Fifth Harmonic(x5)=89.6kHz
sixth Harmonic(x5)=110kHz
seventh Harmonic(x5)=129.4kHz

We are getting frequencies in form of f,3f,5f,7f…..
Cut-off frequency (fc = 1/2πRC) :-

$$\# \; f_c = \frac{1}{2\pi RC}$$

$$= \frac{1}{2 \times 3.14 \times 47 \times 47 \times 10^{-9}}$$

$$= \frac{10^9}{2 \times 3.14 \times 47 \times 47} = \frac{10^9}{6.28 \times 2209}$$

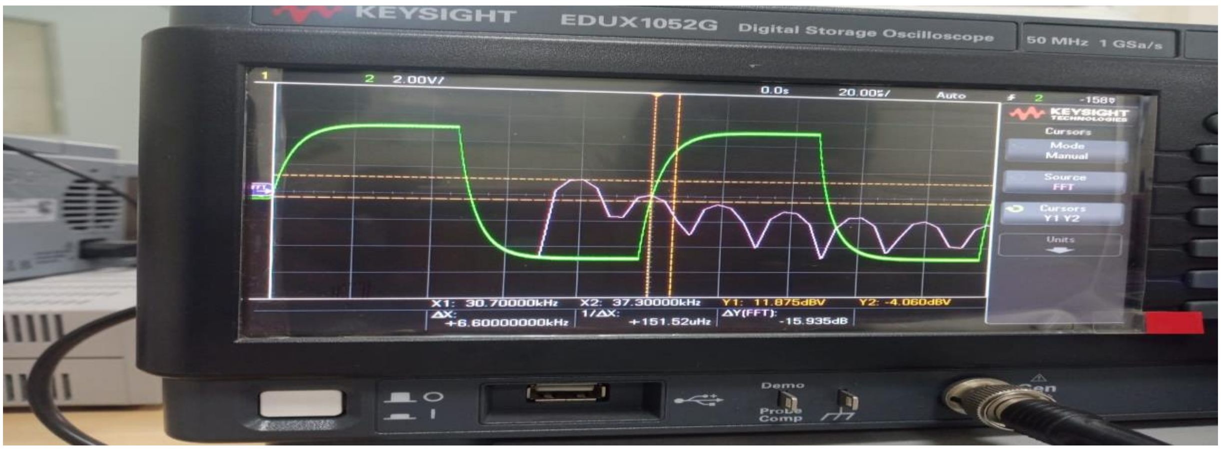
$$\boxed{f_c = 72.06 \text{ kHz}}$$

Measured with::

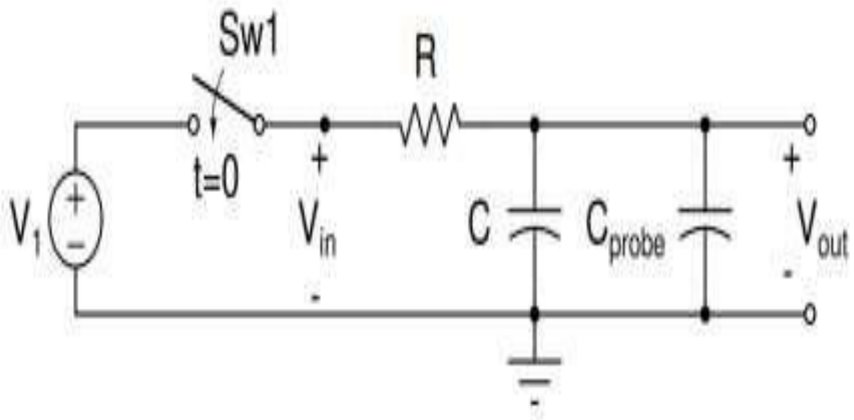
->Probe ratio:- 1:1
->Oscilloscope ratio:- 2:1

	1st harmonic (strength / frequency)	2nd harmonic (strength / frequency)	3rd harmonic (strength / frequency)	4th harmonic (strength / frequency)	5th harmonic (strength / frequency)
Without filter	13.125db	3.75db	-1.25db	4.375db	-6.25db
With filter	11.875db	1.25db	-5.00db	-11.25db	-15.625db

Therefore frequencies above cutoff frequency(72.06KHz) are filtered.

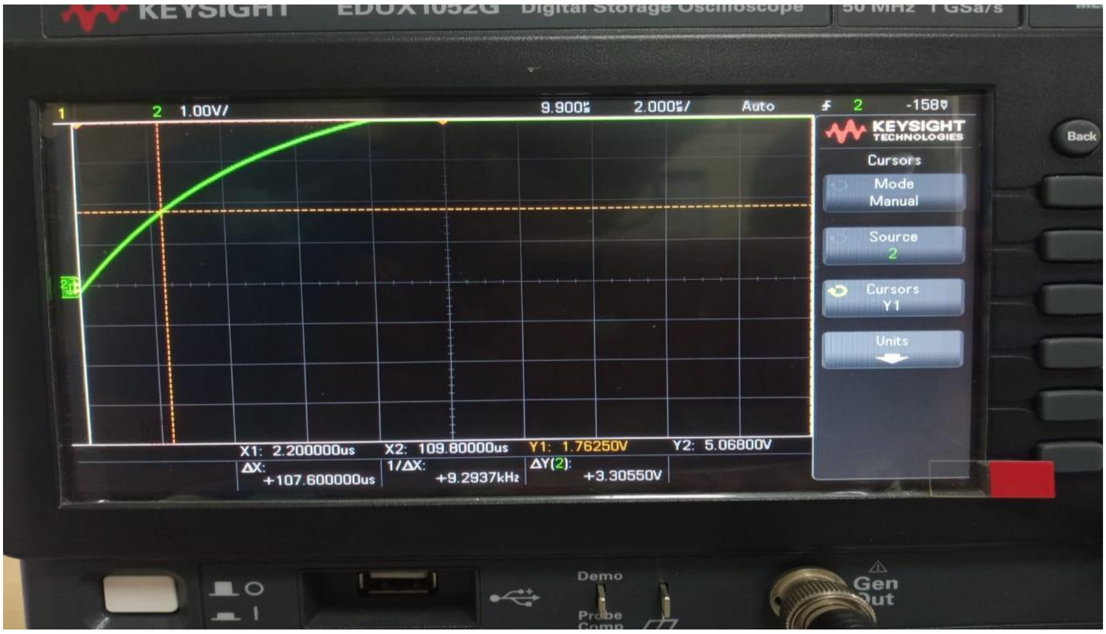


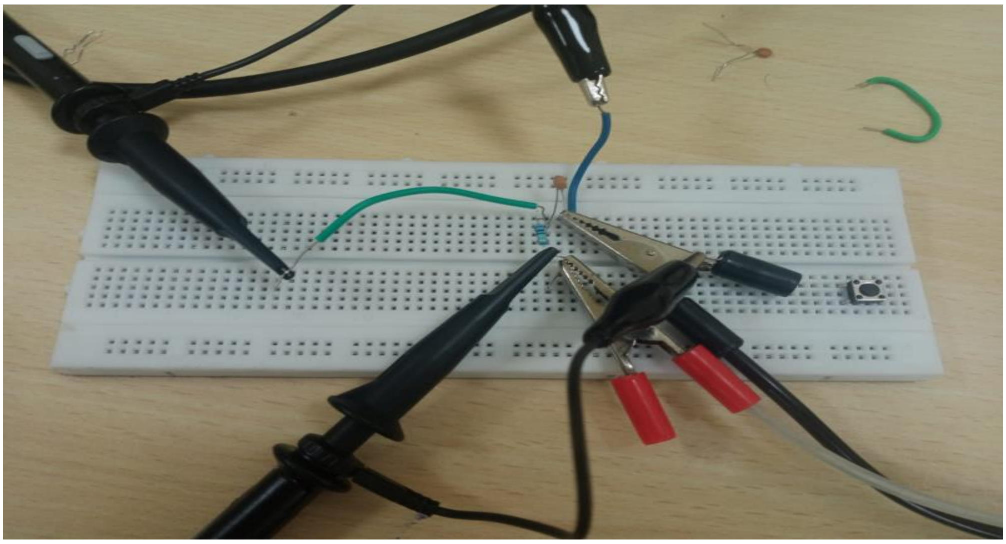
2. Estimate the effective probe-capacitance:



->Take R = 1MΩ and C = 10 pF.
->Then plot input(square wave) and output using two channels of DSO and measure the time constant of the circuit (use probes/DSO in 10x mode).
->To measure the time constant, we apply a step voltage (Vin) to the circuit and observe the output voltage (Vout) using a DSO. The time constant can be calculated by measuring the time taken for the output voltage to rise to 63.2% of its final value after applying the step voltage.
->If the measured time constant is longer than the theoretical value, it indicates the presence of additional capacitance in the circuit, such as probe capacitance, wire capacitance, and breadboard capacitance. ->The effective probe capacitance can be estimated using the following equation: Cprobe = (τmeas - τtheo) / R

Verification of time constant (Measured and calculated):
Time constant =0.63*V


KEYSIGHT
1.00V/
Auto
KEYSIGHT TECHNOLOGIES
Cursors
Mode Manual
Source 2
Cursors Y1
Units
X1: 2.200000us
X2: 109.80000us
Y1: 1.76250V
Y2: 5.06800V
ΔX: +107.600000us
1/ΔX: +9.2937kHz
ΔY(2): +3.30550V
Back
Demo



Cload	Probe factor	Calculated Time Constant (**µs)**	Measured Time Constant (**µs)**	Cprobe (pf)
10pf	1x	10 **(µs)**	124 **(µs)**	114
27pf	1x	27 **(µs)**	119 **(µs)**	109
100pf	1x	100 **(µs)**	133.72	123.7
10pf	10x	10 **(µs)**	42 **(µs)**	27
27pf	10x	27 **(µs)**	23.6 **(µs)**	8.6
100pf	10x	100 **(µs)**	37.8**(µs)**	21.8

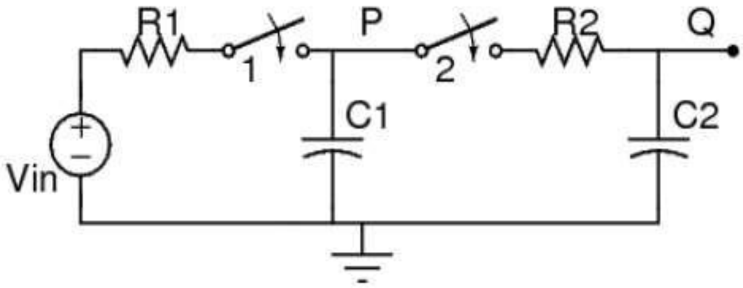
->From the table, we can see that the measured time constants are slightly longer than the calculated time constants for all cases.

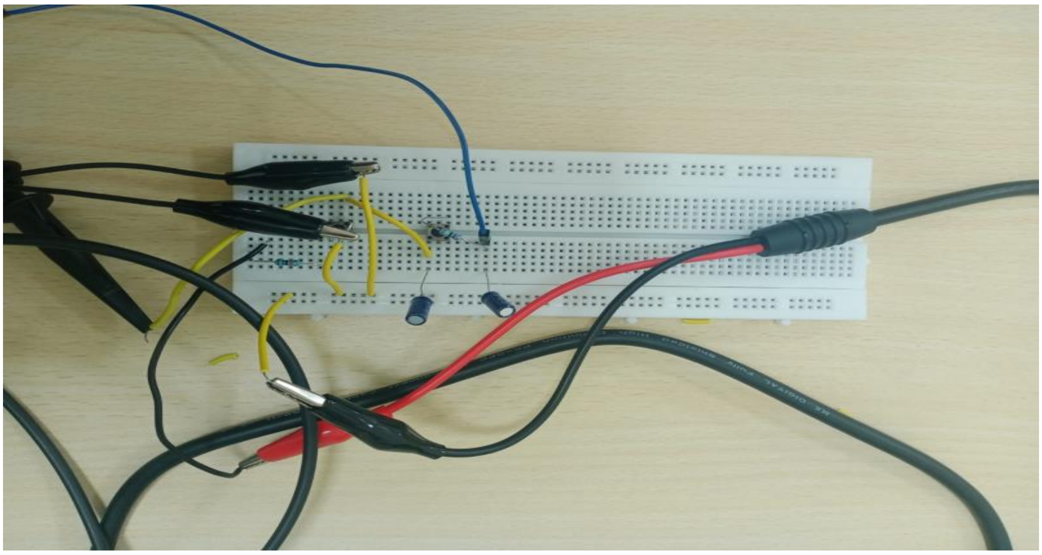
This indicates the presence of additional capacitance in the circuit due to the probe, wires, and breadboard.
The estimated effective probe capacitance (Cprobe) is higher for higher values of Cload and for higher probe factors.
This is because a larger Cload requires a larger capacitance to be charged and discharged, leading to a longer time constant and a larger effective probe capacitance.

Similarly, a higher probe factor increases the effective probe capacitance due to the additional capacitance introduced by the probe.

3. Two capacitor experiment:

In this experiment we will be observing the switching behaviour (charging and dis-charging) of capacitors for the two capacitor network.

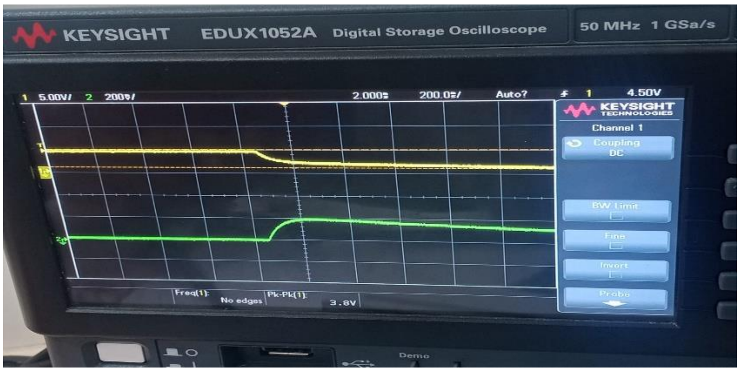




->Connect the circuit a shown above.
->C1 = C2 = 1 μF and R1 = R2 = 100 KΩ.

->Then apply a DC supply voltage of 1V with the help of the function generator.
->Initially, switch 1 is closed (push button is kept pressed) and switch 2 is opened. This allows the capacitor C1 to charge to the supply voltage(1V).
-> Total time taken to reach steady state:-
4*time constant---5*time constant

Resistance (R1)	Capacitance(C1)	VP (initial)	VP (final)	Time taken to reach steady state
100kohm	1uF	0v	1v	530.6ms
10kohm	1uF	0v	1v	55.4ms



->Now when C1 is completely charged, open switch 1 and close switch 2, then observe the voltage across nodes P and Q using probes in the oscilloscope.

->Now change the resistance value to 10k ohm and do the same process as above.

Resistance (R2)	Capacitance(C2)	VP(initial)	VP(final)	Vq(initial)	Vq(final)	Time taken to reach steady state
100k ohm	1uF	1	0.5	0	0.5	264.6 ms
10kohm	1uF	1	0.5	0	0.5	27.4ms

12/1/24

ACC → Exp 1

Oscilloscope → 2 oscilloscope channels
→ a waveform

① Signal → shape
→ amp
→ freq

Sin/sqre

Make setting → two places
① oscilloscope
② prob (1x & 10x)

Cursor factor → doubt

mention (peak to peak & freq)
for both 1x & 10x signal.

* $\boxed{\text{Amp of } V_{osc} = \frac{\text{Osc factor}}{\text{Probe factor}} \times V_{in}}$

Sin wave 10 kHz

centre freq → around ~~centre~~ 10 kHz fundamental freq

Let
fundam. = 10 kHz

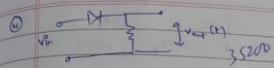
Center
Span → ?

Span → width of freq band that to be analyze

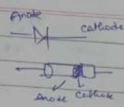
Centre → The freq in middle of Band freq's by which the band is identified together with bandwidth.

Type	Amp Vin V_{pp}	Freq	prob factor	Osc factor	V_{osc}	$V_{in} = \frac{\text{osc f}}{\text{pro f}} \cdot V_{in}$

④



3520Ω



LAB (exp) 13/1/24

① RC specifications of probe.

10 : 1 75 MHz

10 MΩ / 15 pF

1 : 1

1 MΩ / 100 pF

⇒ (ii) Sin Wave:

$\Delta V_{pp} = 2.0875$ V

$\Delta x = 100.0000$ μs

$f = 10$ kHz

Type	Amp (Vin)	freq (Hz)	prob	OSC
~~Square~~		~~1 kHz~~		
Square	1.31	1.0062 kHz	10	

?

Demo – Square
1.0002 kHz
1.25 V

FFT

(v) Without filter

1^{st} harmonic

x_1 (freq) = 10 kHz

y_1 (strength) = 13.125 dBV

2^{nd}

$x_2 \longrightarrow 30.2$ kHz

$y_2 \longrightarrow 3.75$ dBV

$x_3 \longrightarrow 50$ kHz

$y_3 \longrightarrow -1.25$ dBV

With filter:

$x_1 \longrightarrow 10$
$y_1 \longrightarrow 11.875$ dBV

$x_2 \longrightarrow 30.2$
$y_2 \longrightarrow 1.25$ dBV

$x_3 \longrightarrow 50$
$y_3 \longrightarrow -5.0$ dBV

$x_4 \to 70$
$y_4 \to -11.25$ dBV

$x_5 \to 89.6$
$y_5 \to -15.625$ dBV

x_6 110
y_6 −18.75 dBV

$x_7 \to 127.4$
$y_7 \to -20.658$ dBV

R = 47 Ω
C = 47 nF

$RC = 2.209 \times 10^{-6} = \tau$

$f_c = 72.06$ kHz