# EXPERIMENT-1

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## Problem 1(a):

### Aim:

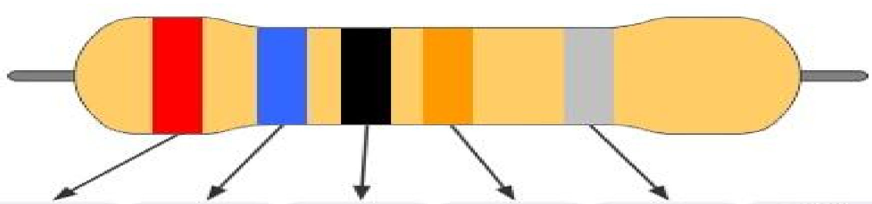
To measure the resistance using three low-wattage resistors using the colour coding and multimeter. Also, find the deviation from measursed and expected value.

### Material Required:

Low-wattage resistor (1kΩ, 2kΩ, 4,7kΩ), Multimeter

### Procedure:

Using the colour coding given below, resistance of the resistor is calculated.



| | 1st digit | 2nd digit | 3rd digit | multiply | tolerance | TCR (ppm/K) |
|---|---|---|---|---|---|---|
| Black | 0 | 0 | 0 | 1 | 1% (F) | 100 |
| Brown | 1 | 1 | 1 | 10 | 2% (G) | 50 |
| Red | 2 | 2 | 2 | 100 | | 15 |
| Orange | 3 | 3 | 3 | 1K | | 25 |
| Yellow | 4 | 4 | 4 | 10K | | |
| Green | 5 | 5 | 5 | 100K | 0.5% (D) | |
| Blue | 6 | 6 | 6 | 1M | 0.25% (C) | 10 |
| Violet | 7 | 7 | 7 | 10M | 0.1% (B) | 5 |
| Gray | 8 | 8 | 8 | 100M | 0.05% (A) | |
| White | 9 | 9 | 9 | 1G | | |
| Gold | | | | 0.1 | 5% (J) | |
| Silver | | | | 0.01 | 10% (K) | |
| None | | | | | 20% (M) | |

## Observations:

Calculating 1kΩ using colour coding,

| 1st digit | 2nd digit | 3rd digit | Multiplier | Tolerance |
|---|---|---|---|---|
| Brown(1) | Black(0) | Black(0) | Brown(10) | Gold($\pm 5\%$) |

So, the resistance of the above resistor through color codes is:

$R_{cc} =$ (1 × 100 + 0 × 10 + 0 × 1) × 10 ± 5%

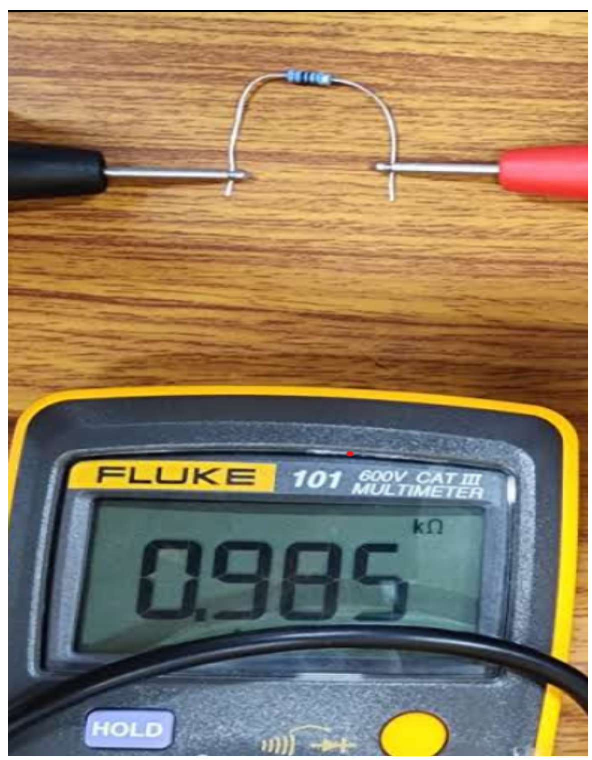
$R_{cc} =$ 1 ± 5% kΩ

Calculating 1kΩ using Multimeter,

$R_{mm}$ = 0.985 kΩ

Error percentage,

$\Delta = \frac{R_{mm} - R_{cc}}{R_{cc}} = \frac{985-1000}{1000} \times 100 = -1.5\%$



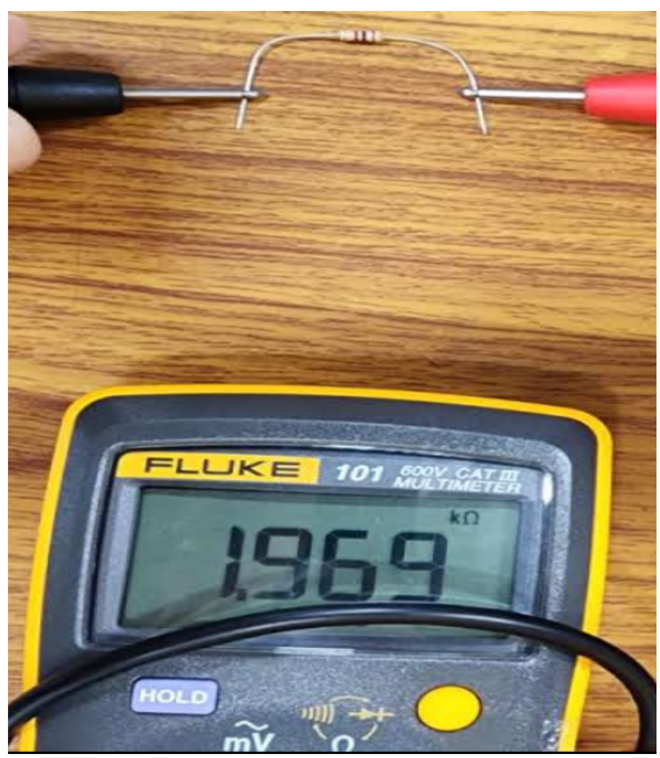
Calculating 2kΩ using colour coding,

| 1st digit | 2nd digit | 3rd digit | Multiplier | Tolerance |
|---|---|---|---|---|
| - | Red(2) | Black(0) | Red($10^2$) | Gold($\pm5\%$) |

So, the resistance of the above resistor through color codes is:

$R_{cc} =$ (0 × 100 + 2 × 10 + 0 × 1) × 100 ± 5%

$R_{cc} = 2 \pm 5\%$ kΩ




Calculating 2kΩ using Multimeter,

$R_{mm}$ = 1.969 kΩ

Error percentage,

$$\Delta = \frac{R_{mm} - R_{cc}}{R_{cc}} = \frac{1965-2000}{1000} \times 100 = -3.5\%$$

Calculating 4.7kΩ using colour coding,

| 1st digit | 2nd digit | 3rd digit | Multiplier | Tolerance |
|---|---|---|---|---|
| Yellow(4) | Violet(7) | Black(0) | Brown(10) | Gold(±5%) |

So, the resistance of the above resistor through color codes is:

$R_{cc} =$ (4 × 100 + 7 × 10 + 0 × 1) × 10 ± 5%

$R_{cc}$ = 4700 ± 5% kΩ

Calculating 4.7kΩ using Multimeter,

$R_{mm}$ = 4.63 kΩ

Error percentage,

$\Delta = \frac{R_{mm} - R_{cc}}{R_{cc}} = \frac{4630-4700}{4700} \times 100 = -1.4\%$

## Problem 1(b):

## Aim:

Measure the resistance of two high-wattage resistance using (a) Multimeter (b) use Ohm's law & the power supply and plot the V-I curves, limitations of power supply.

## Material Required:

Two high wattage resistors (47Ω and 100Ω), Breadboard, Bench power supply, wires.

## Theory:

This Law states that the current flowing through a conductor between two points (I) is directly proportional to the voltage difference across the two points of the conductor (V). Mathematically stated as,

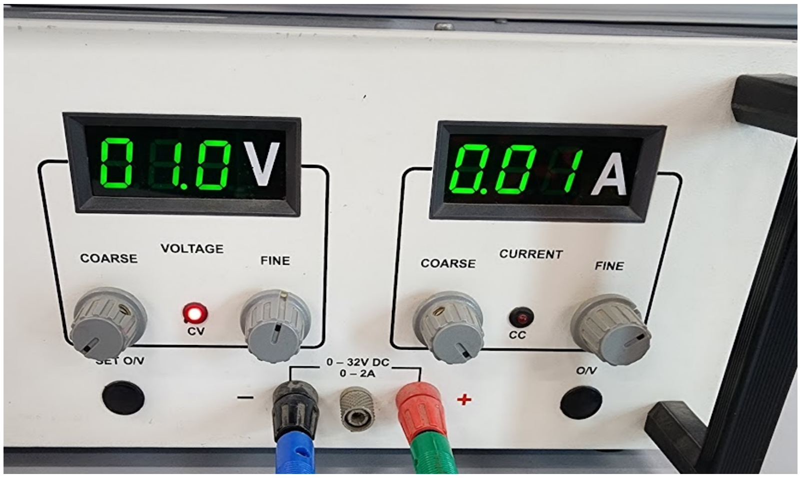
$V \propto I$

$Resistance\ = R = \frac{V}{I}$

So, a graph between V and I is a straight line in ideal conditions.

## Procedure:

1. Taking the high wattage resistors and measure their resistances using a multimeter.
2. Now using the bench power supply to supply DC voltage across the resistor and noting the current through the resistor.
3. Keep increasing the voltage slowly, noting the current and plot a V-I graph.
4. Now calculate the resistance using the V-I graph and calculate the percentage error in the two resistors.



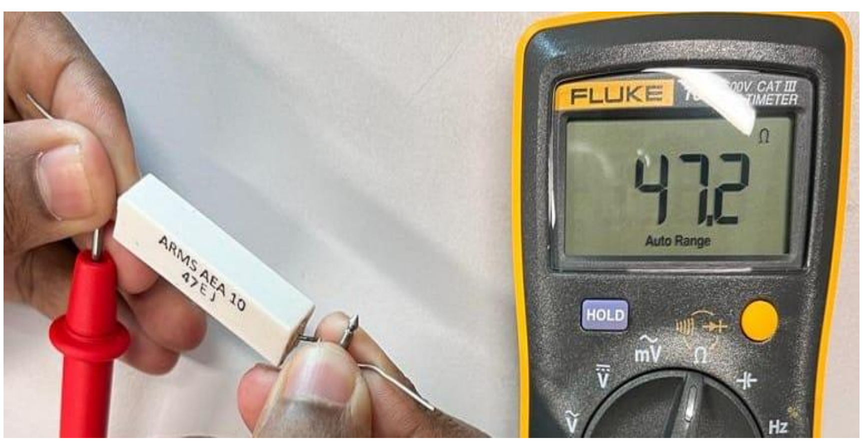

## Observations:

We observed that the ohm law is followed by the two resistors. The deviation calculated is small due to the lack of precision in the bench power supply.

For 47Ω,

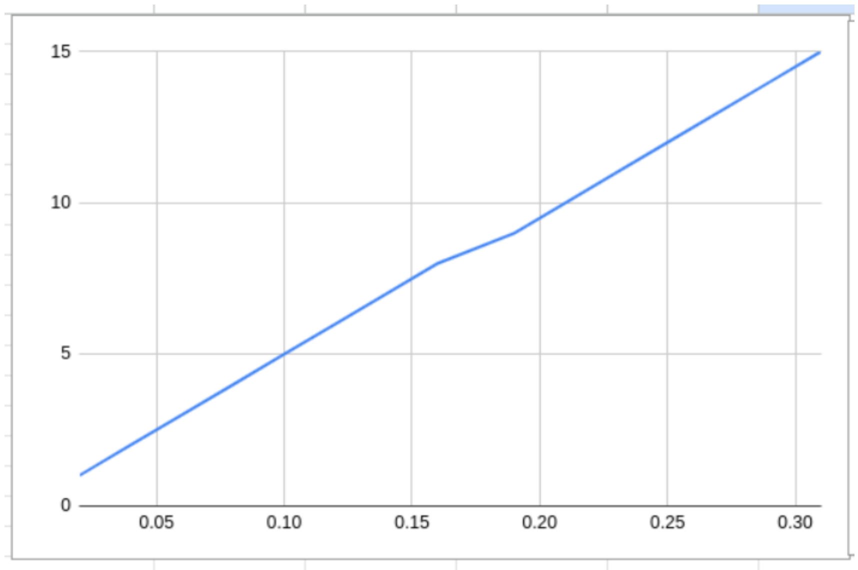
Using the multimeter resistance recorded is:

$R_{MV}$= 47.2Ω



Using the V vs I plot, resistance recorded is:

$R_{CV}$= 48.583Ω



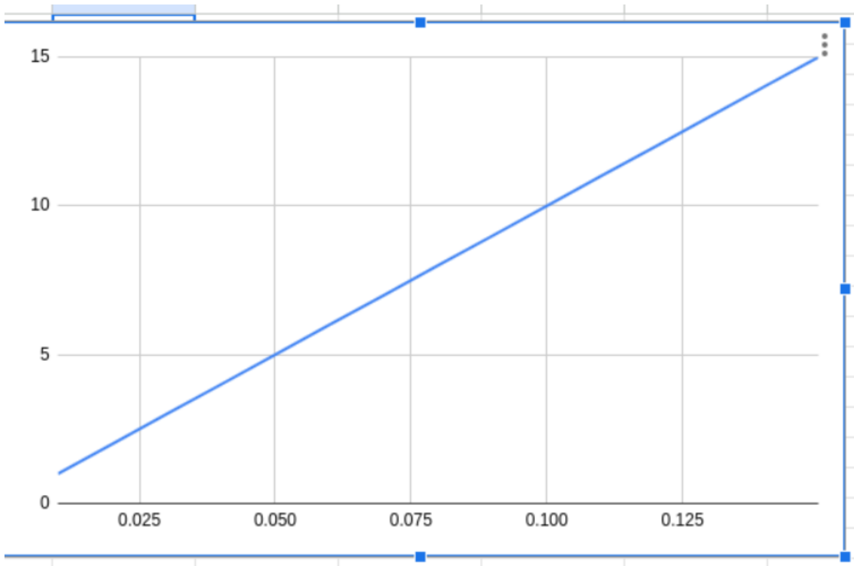

For 100Ω,

Using the multimeter resistance recorded is:

$R_{MV}$ = 101.5Ω


Using the V vs I plot, resistance recorded is:

$R_{CV} = 100\Omega$




| 1 | V | I(47Ω) | I(100Ω) |
|---|---|---|---|
| 2 | 1 | 0.02 | 0.01 |
| 3 | 2 | 0.04 | 0.02 |
| 4 | 3 | 0.06 | 0.03 |
| 5 | 4 | 0.08 | 0.04 |
| 6 | 5 | 0.1 | 0.05 |
| 7 | 6 | 0.12 | 0.06 |
| 8 | 7 | 0.14 | 0.07 |
| 9 | 8 | 0.16 | 0.08 |
| 10 | 9 | 0.19 | 0.09 |
| 11 | 10 | 0.21 | 0.1 |
| 12 | 11 | 0.23 | 0.11 |
| 13 | 12 | 0.25 | 0.12 |
| 14 | 13 | 0.27 | 0.13 |
| 15 | 14 | 0.29 | 0.14 |
| 16 | 15 | 0.31 | 0.15 |
| 17 | | | |
| 18 | 120 | 2.47 | 1.2 |
| 19 | R---> | 48.58299595 | 100 |

Error percentage,

$$\Delta = \frac{R_{MV} - R_{CV}}{R_{CV}} = \frac{47.2-48.583}{48.583}\times 100 = -2.847\%$$

$$\Delta = \frac{R_{MV} - R_{CV}}{R_{CV}} = \frac{101.5-100}{100}\times 100 = 1.5\%$$

Note: In case of the 100Ω resistor, no error could be record due to lack of precision in bench power supply.

## Problem 2(a):

### Aim:

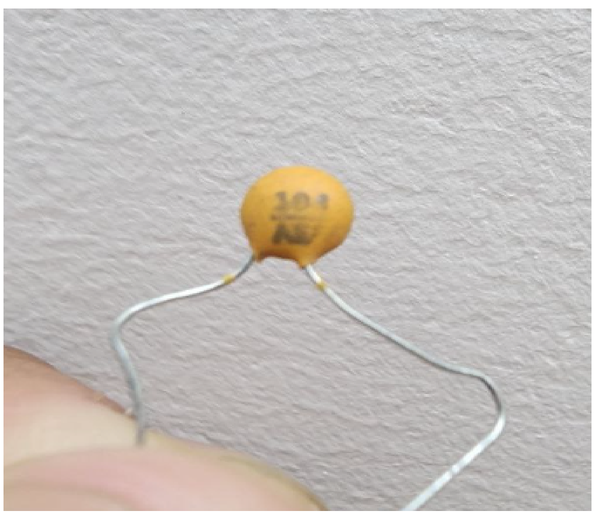
To measure the capacitance of two capacitors (one each in nano farad, micro farad).

### Material Required:

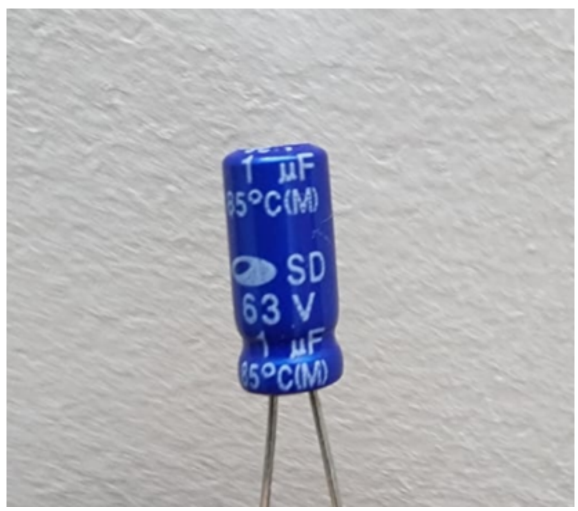
100nF and 1µF capacitors, Multimeter.

### Theory:

If a capacitor has three terms, then the first two digits are the value of the capacitance of the capacitor and the third term is the multiplier.In some capacitor proper value of capacitance is already given.



100nF




1µF

# Problem 2(b):

## Aim:

Measuring the value of the two capacitance of the capacitors in Q2a using (a) multimeter (b) transient response of the RC

## Material Required:

2 capacitors (1μF, 100nF), 3 low-wattage resistors (1 kΩ, 2kΩ , 4.7kΩ) , multimeter, breadboard, wires, function generator, oscilloscope.

## Theory:

In a RC-Circuit the voltage across the capacitor is given by the equation

$$V_{cap} = V_0(1 - e^{t/\tau})$$

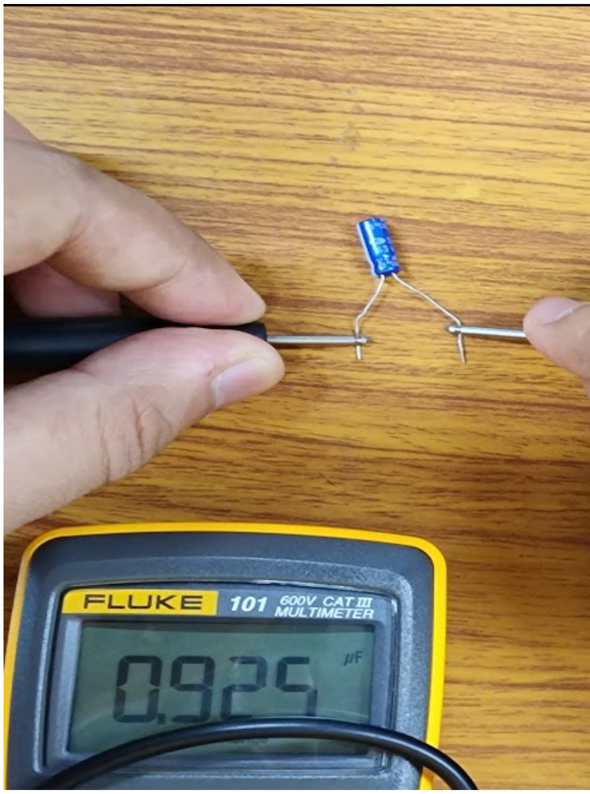
Where, $V_0$ is the amplitude of the input signal.

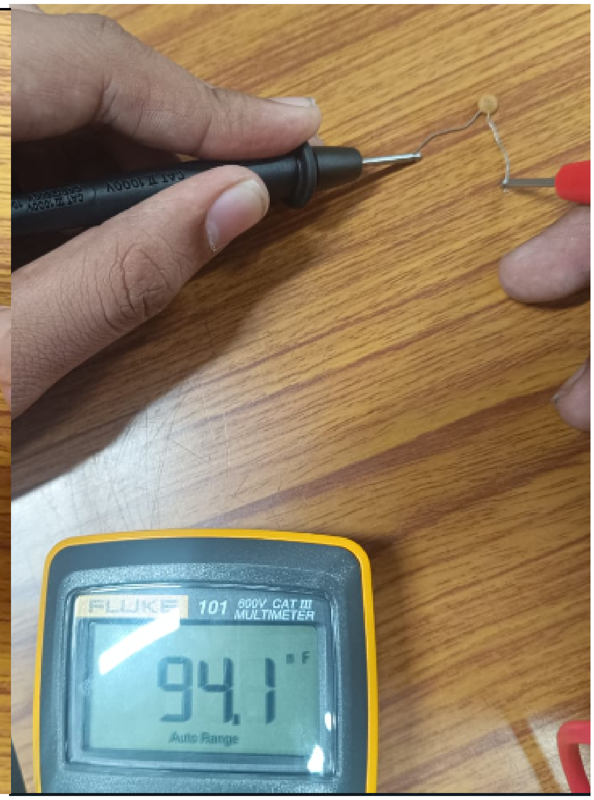
τ is the time constant ( $\tau = RC$ )

So, in one time constant $V_{cap} \cong 0.63V_0$

## Procedure:

1. We measure the capacitance of the two capacitor using the multimeter




$C_{mm} = 0.925\mu F$ $C_{mm} = 94.1nF$

1. We take same resistor as in  Q1a and make a RC circuit in order to check the response for the two capacitor with each resistor.
2. The input is given from the function generator as square waves.
3. The frequency of the function generator is kept less than the time constant for the capacitor to charge to its full capacity.
4. We use thecursor in DSO to find the time difference(i.e the time constant) corresponding to $0.63V_0$ and voltage across capacitor is recorded.

Error percentage = $\frac{C_{cc}-C_{mm}}{C_{mm}}$

## Observations:

For $1k\Omega and\ 1\mu F$ ;


$R_{mm}$=0.985kΩ

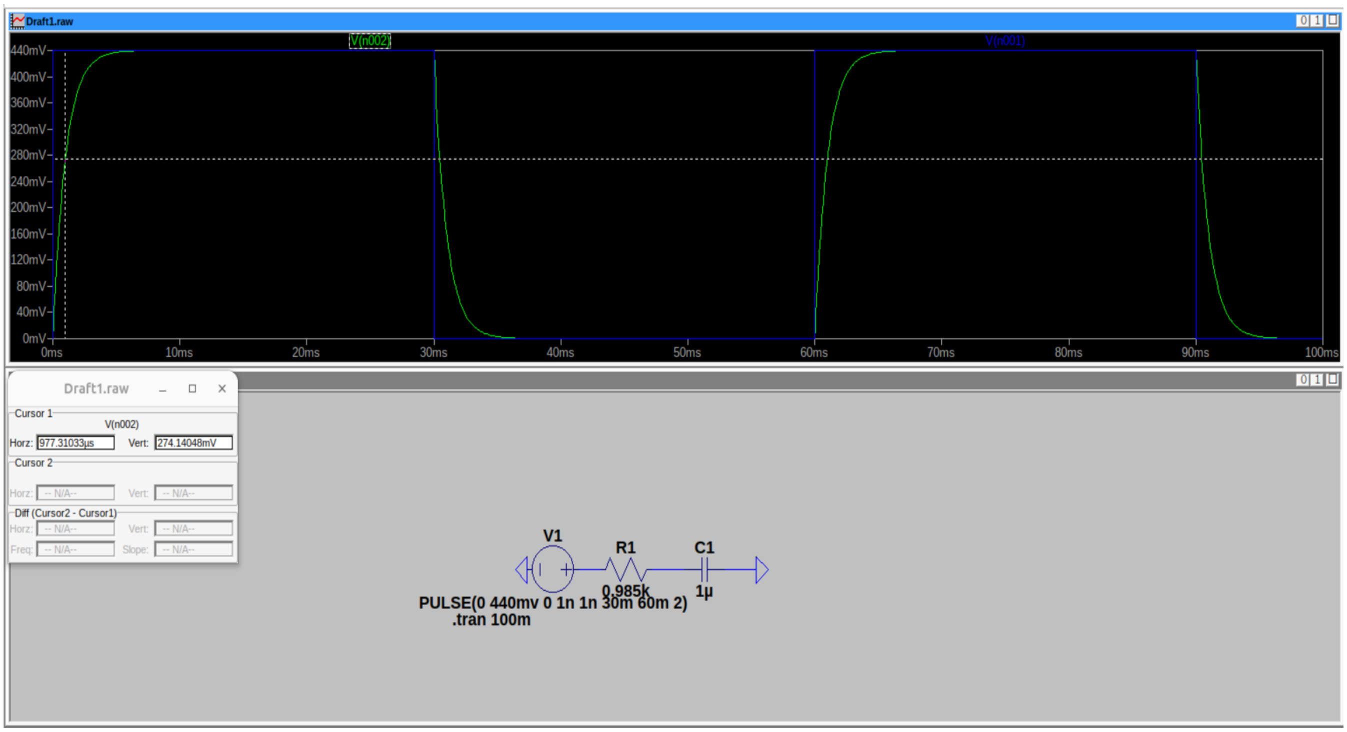
$C_{mm}$=0.925µF

Calculated time constant = 960µs

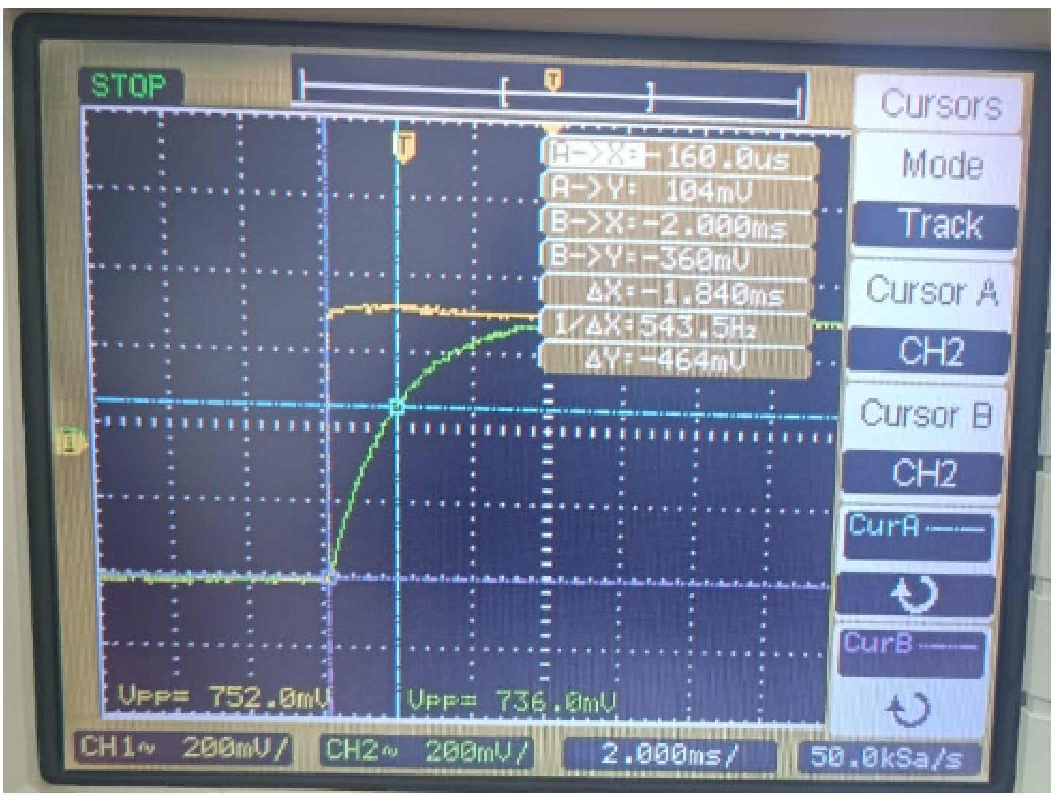
Calcutated capacitance = $C_{cc}$ = 960/0.985 = 0.974µF

Error = 5.3%

LTspice reading:




For $2k\Omega and\ 1\mu F$ ;



$R_{mm}$=1.969kΩ

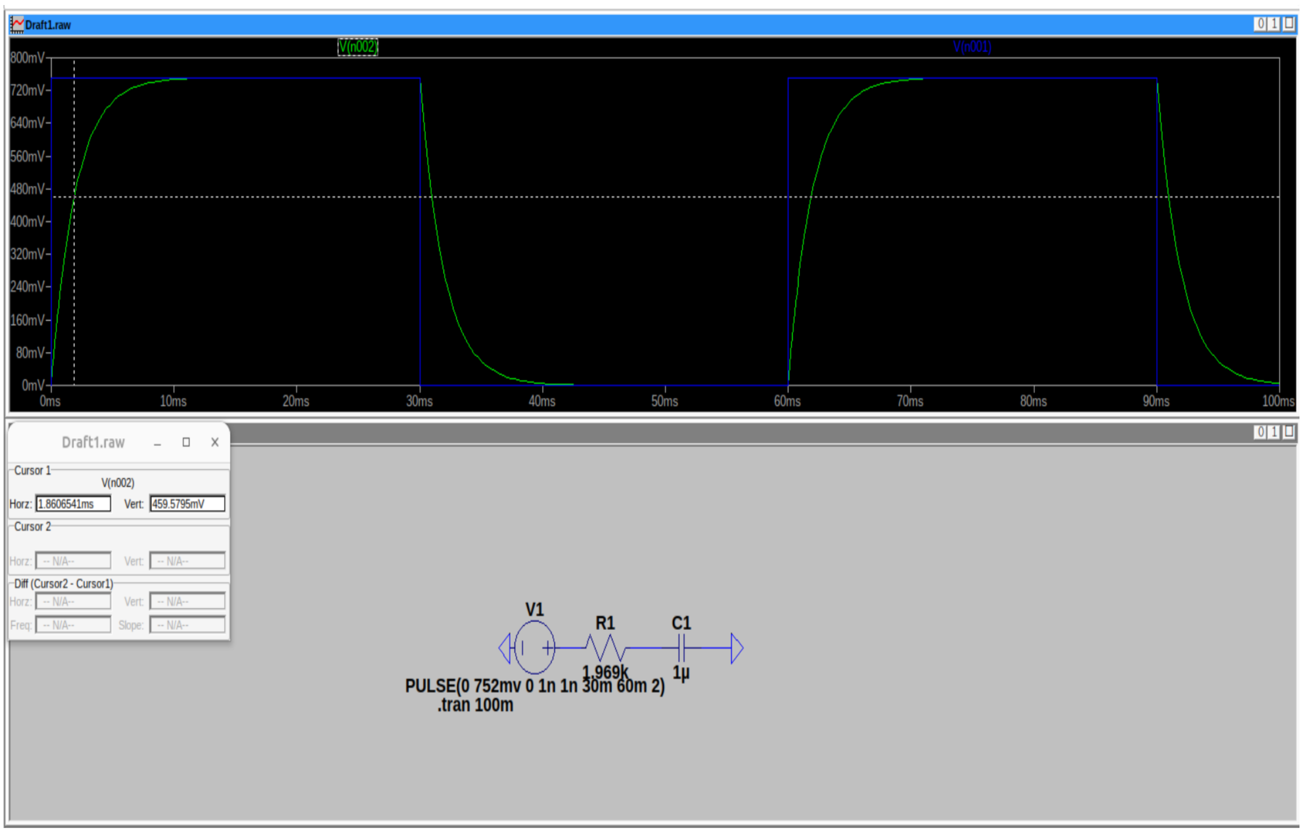
$C_{mm}$=0.925$\mu$F

Calculated time constant = 1840μs

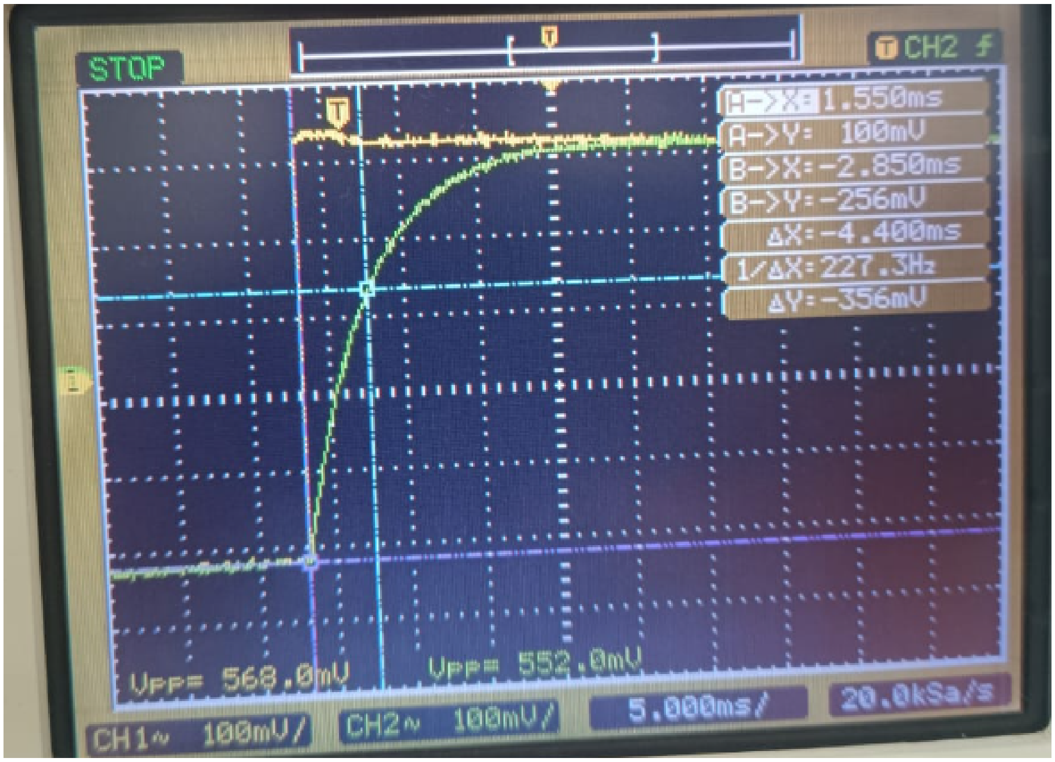
Calcutated capacitance = $C_{cc}$ = 1840/1.969 = 0.934$\mu$F

Error = 0.972%

LTspice reading:



For $4.7\mathrm{k}\Omega and\ 1\mu F$ ;




$R_{mm}$=4.63k$\Omega$

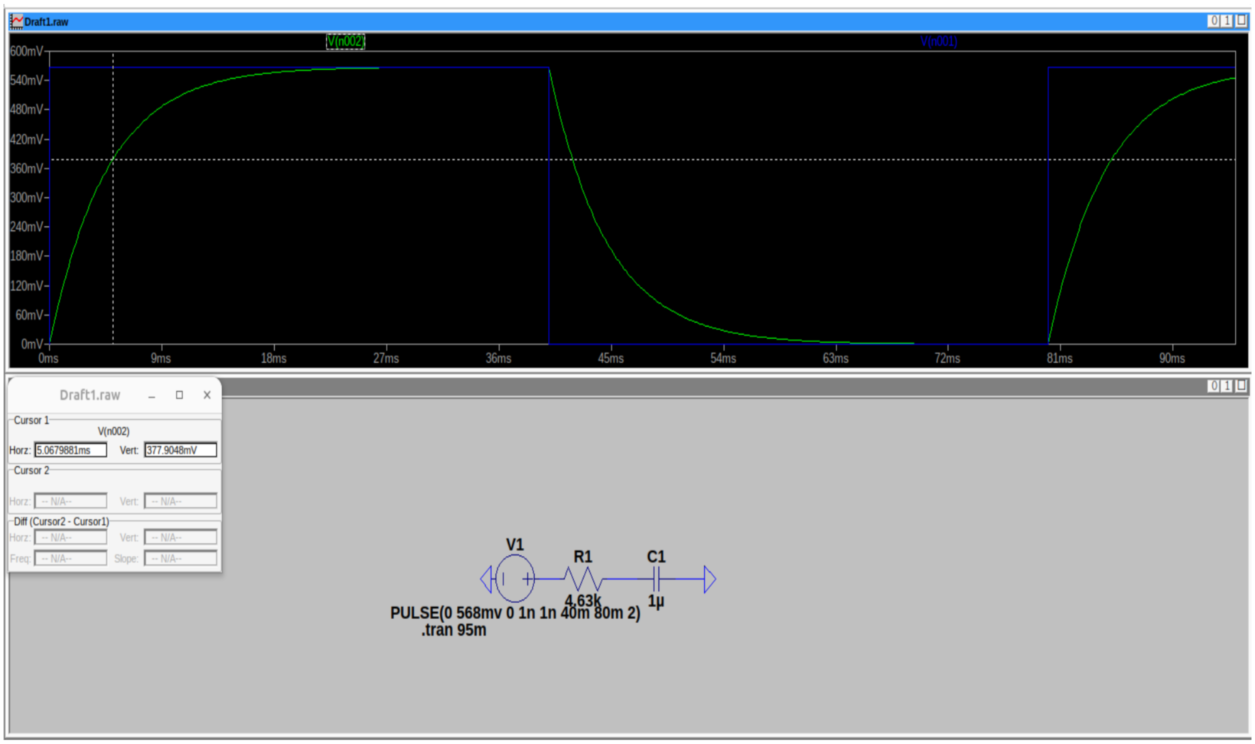
$C_{mm}$=0.925$\mu$F

Calculated time constant = 1440μs

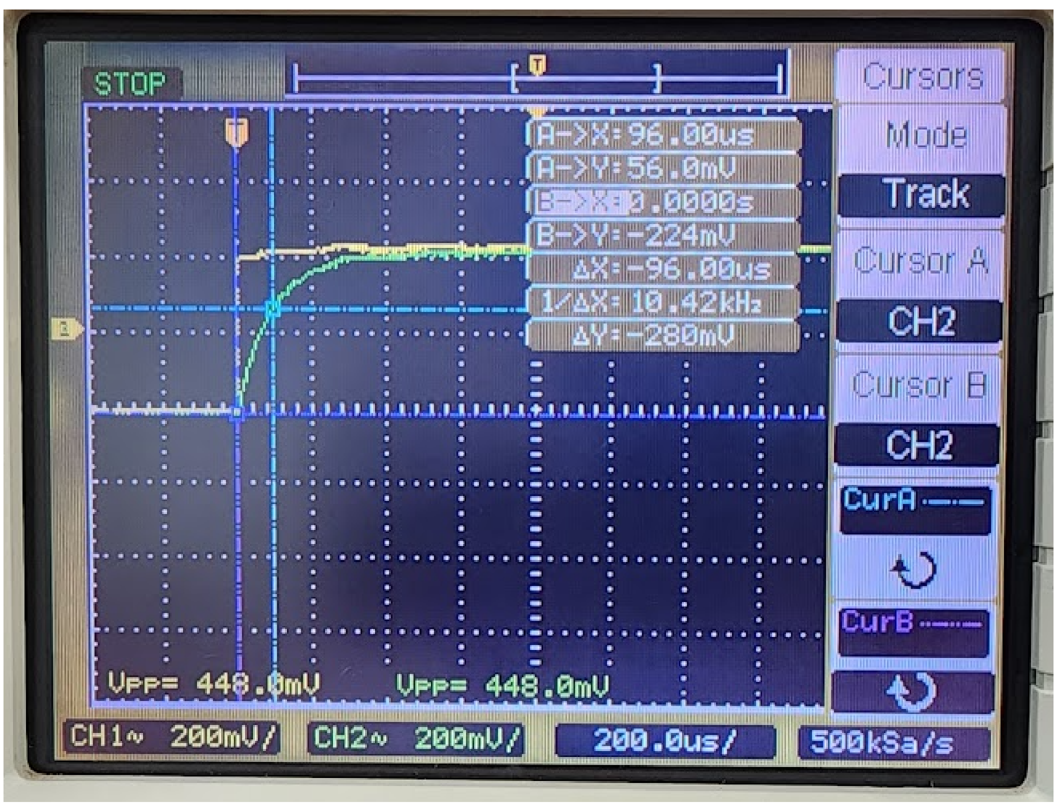
Calcutated capacitance = $C_{cc}$ = 1440/4.64 = 0.95$\mu$F

Error = 2.7%

LTspice reading:




For $1\text{k}\Omega and\ 100nF$ ;



$R_{mm}$=0.985$\mathrm{k}\Omega$

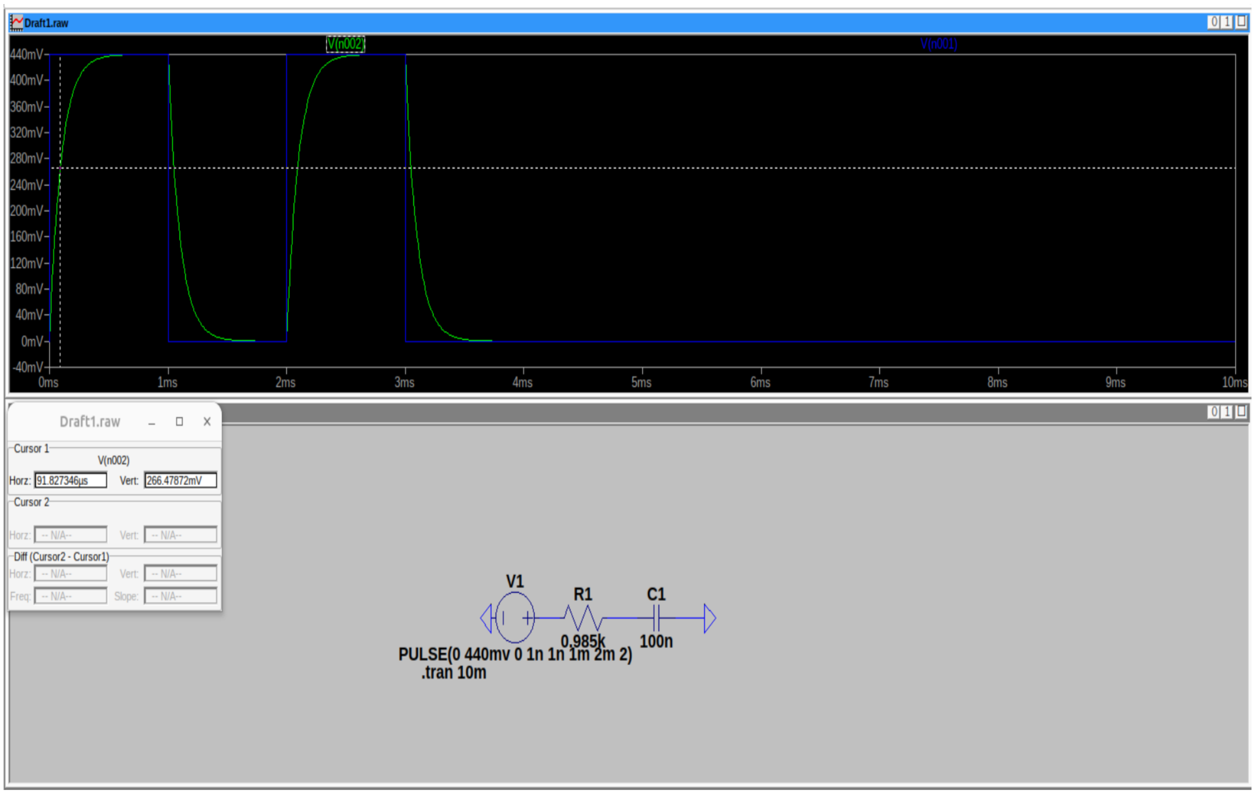
$C_{mm}$=94.1$nF$

Calculated time constant = 96μs

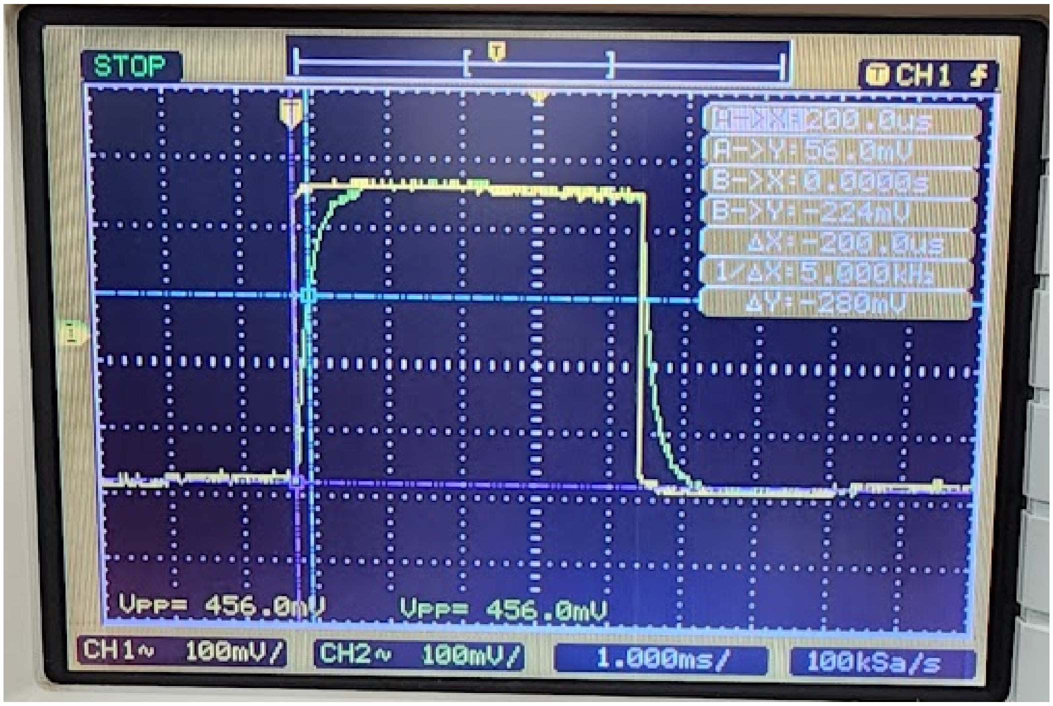
Calcutated capacitance = $C_{cc}$ = 96/0.985 = 97.4$nF$

Error = 3.51%

LTspice reading:



For $2\mathrm{k}\Omega and\ 100nF$ ;




$R_{mm}$=1.969$\mathrm{k}\Omega$

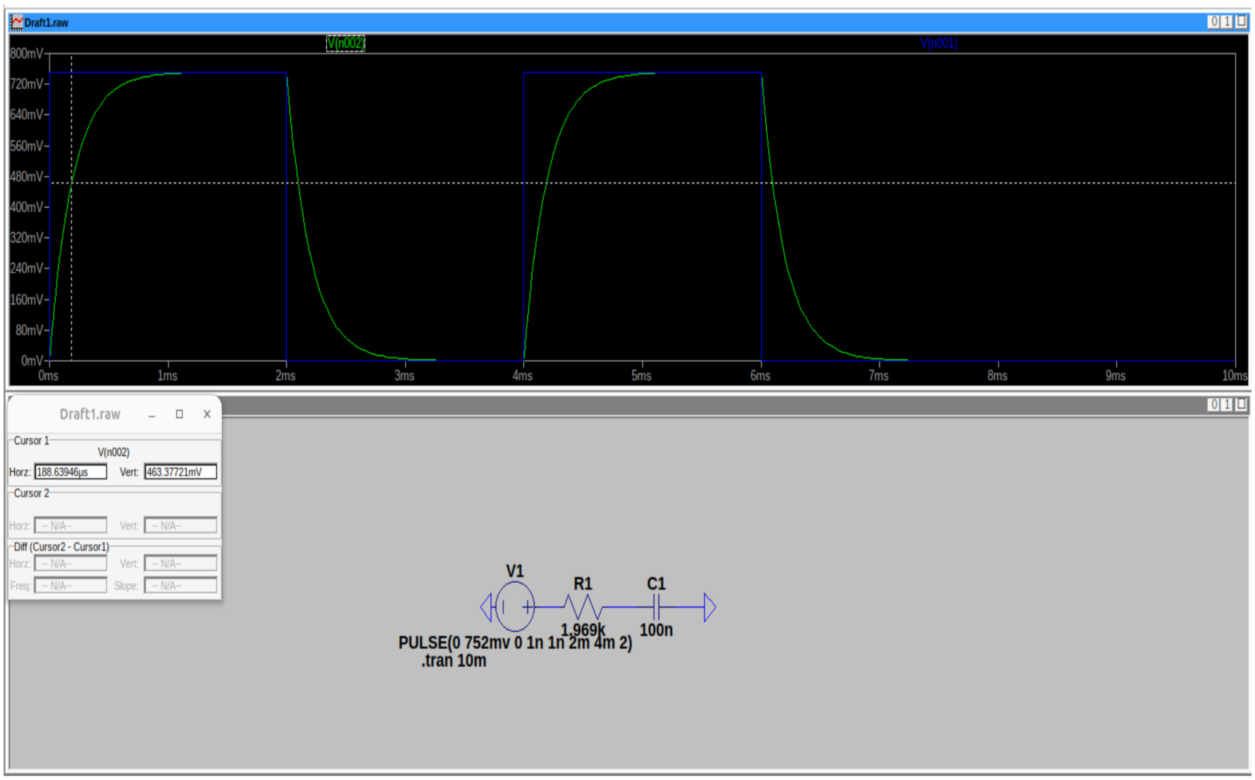
$C_{mm}$=94.1$nF$

Calculated time constant = 200μs

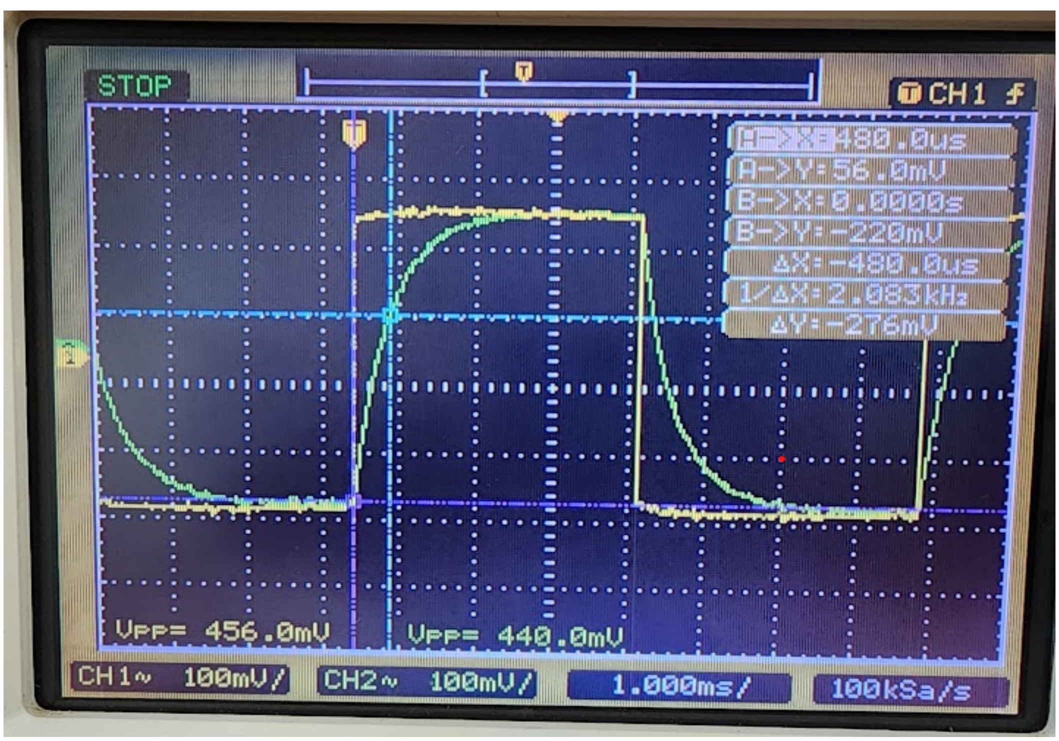
Calcutated capacitance = $C_{cc}$ = 200/1.969 = 101.5$nF$

Error = 7.68%

LTspice reading:




For $4.7k\Omega and\ 100nF$ ;



$R_{mm}$=4.63kΩ

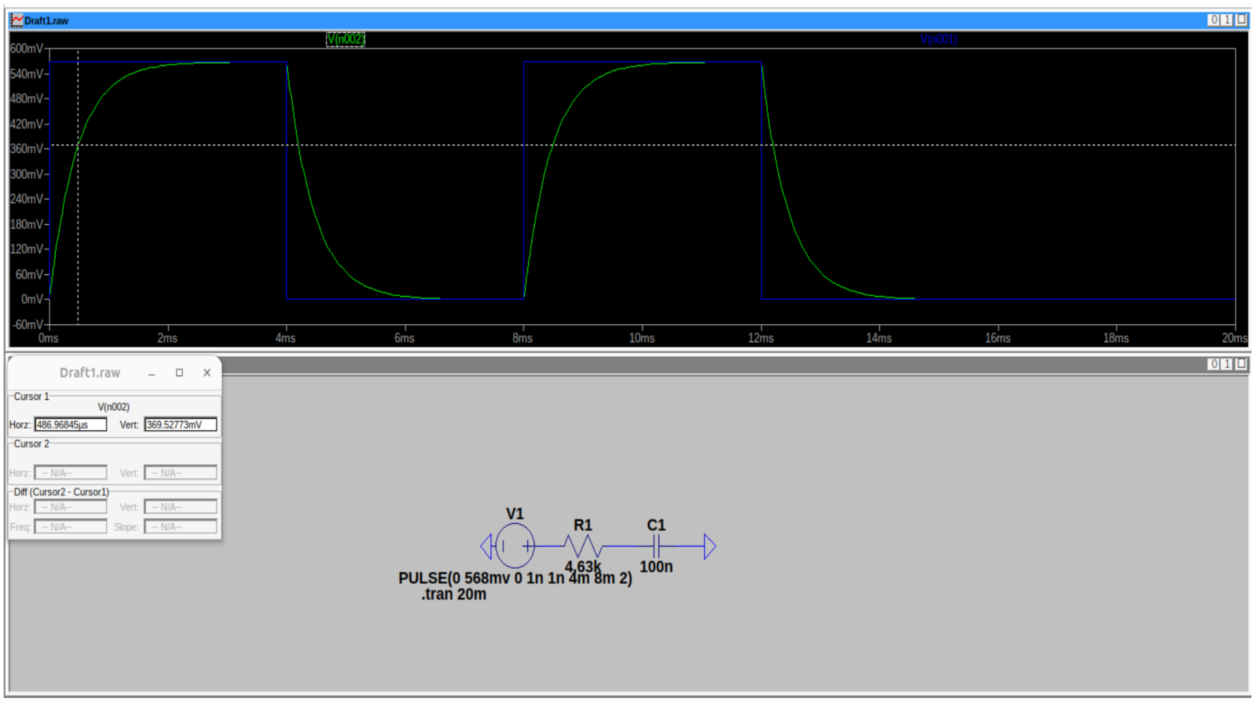
$C_{mm}$=94.1$nF$

Calculated time constant = 480μs

Calcutated capacitance = $C_{cc}$ = 480/4.63 = 103.2$nF$

Error = 9.67%

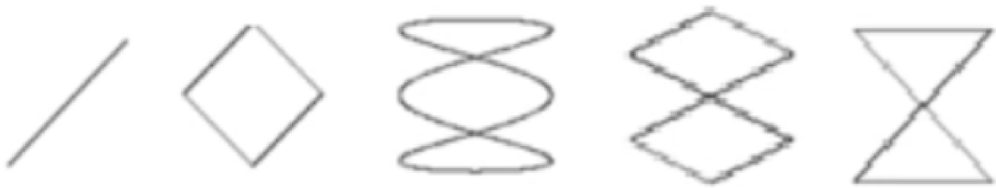
LTspice reading:



## Problem 3:

### Aim:

Learn about Lissajous figures and generate the some given patterns on the CRO.



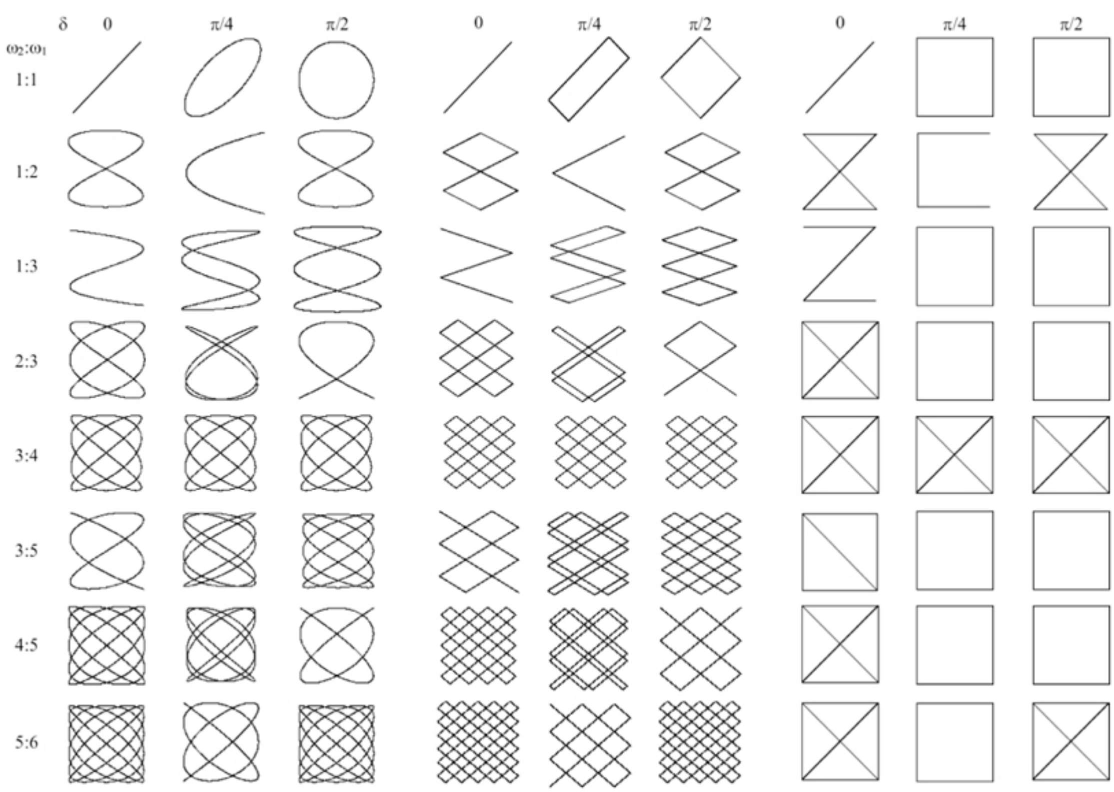
(a) (b) (c) (d) (e)

### Material Required:

Wires, function generator, oscilloscope.

### Theory:

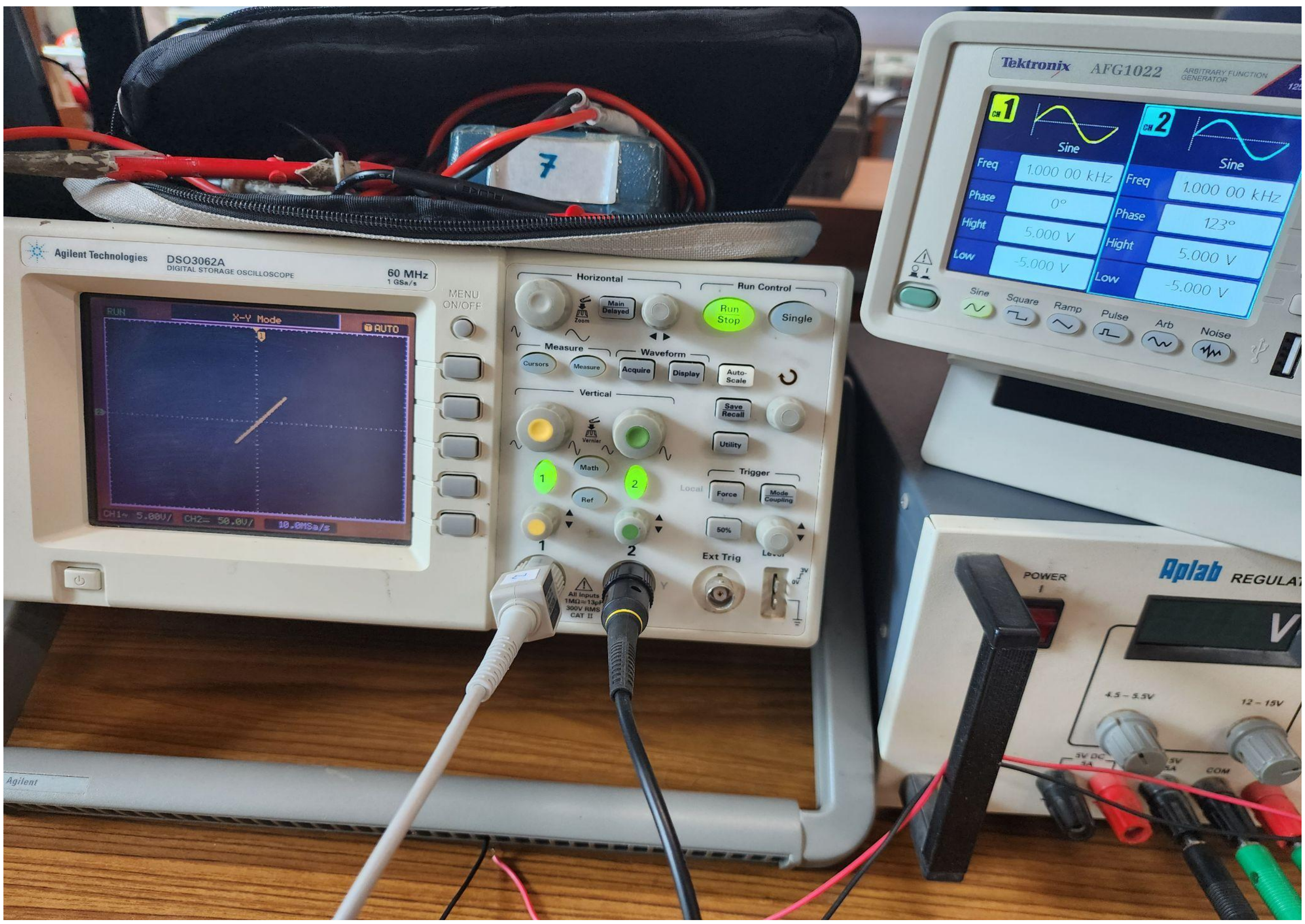
Lissajous figures are based on the concept of superposition, where two perpendicular signals in X and Y interferes. This creates a complex pattern that depends on the input signals' Amplitude, Phase difference, symmetry and frequency ratio.



## Procedure:

1. Both probe of the DSO is connected to the function generator.
2. Function generator is operated in the “both” mod.
3. Properties like amplitude, phase difference, symmetry and frequency ratio of the input is tuned to generate the above pattern.

## Observations:

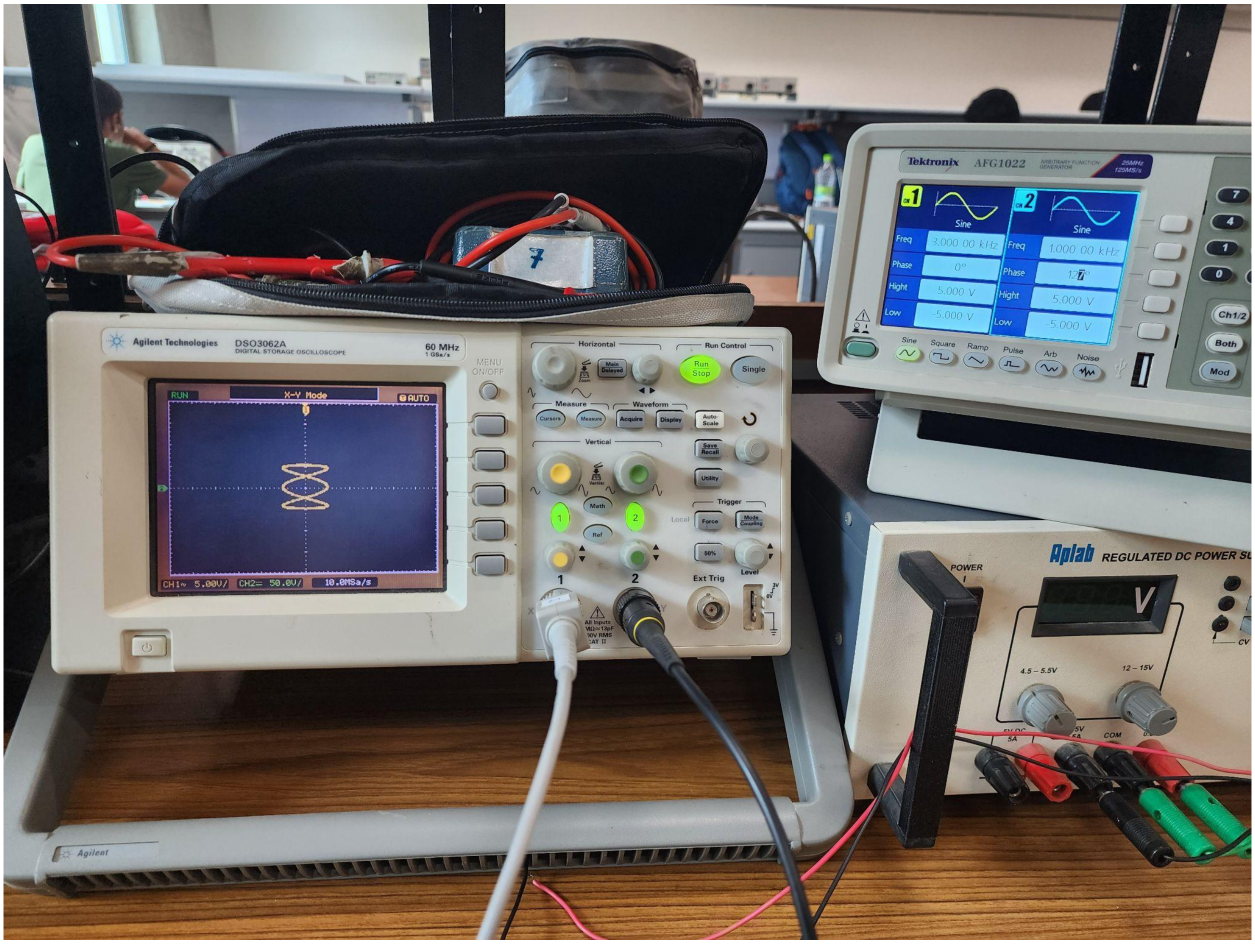



The above pattern is obtained by

- Both sine wave
- Amplitude in 1:1
- Frequncy in 1:1
- Phase difference of 123°
- Symmetry at 50%

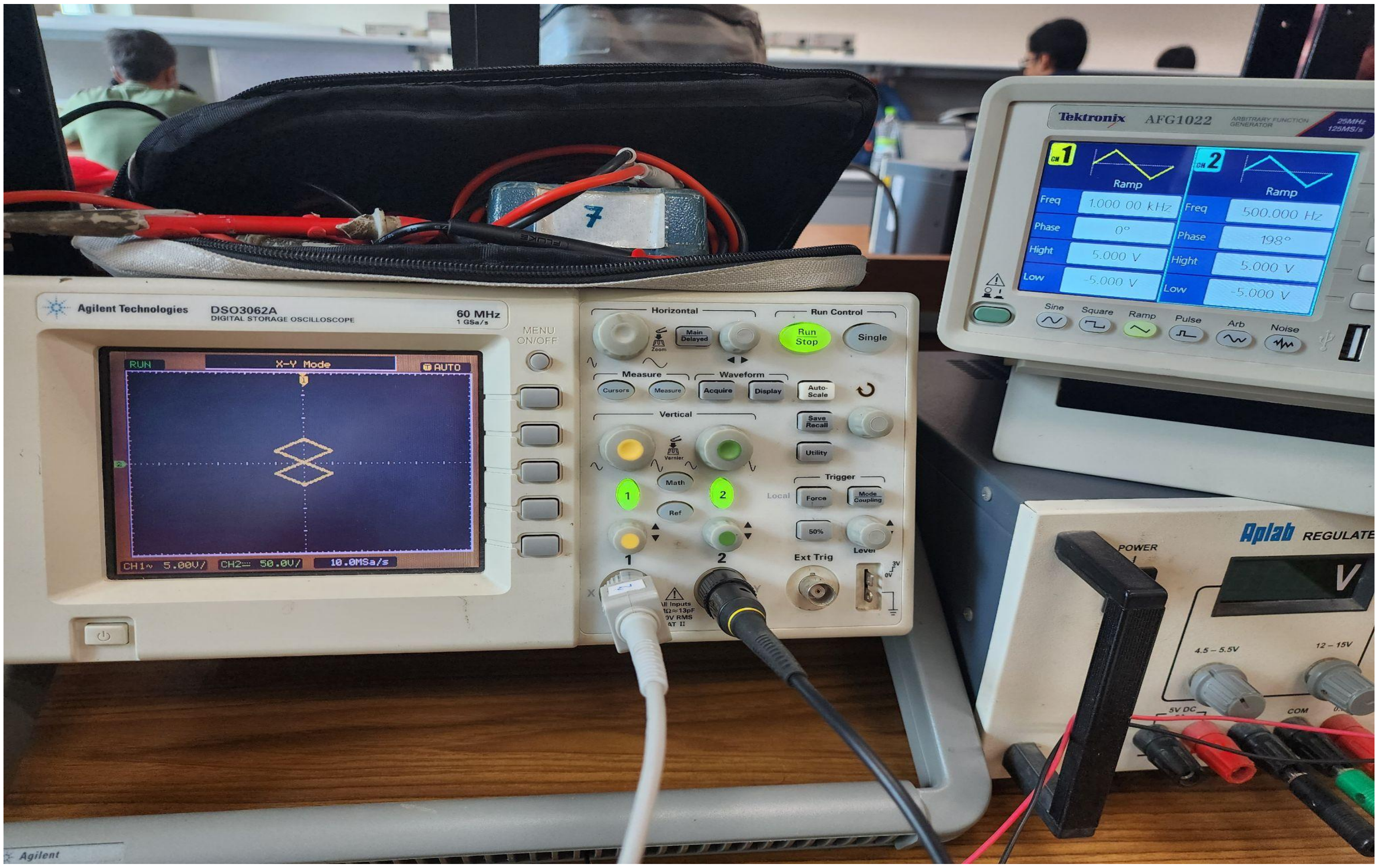

The above pattern is obtained by

- Both ramp wave
- Amplitude in 1:1
- Frequncy in 1:1
- Phase difference of 144°
- Symmetry at 50%




The above pattern is obtained by

- Both sin wave
- Amplitude in 1:1
- Frequncy in 3:1
- Phase difference of 127°
- Symmetry at 50%

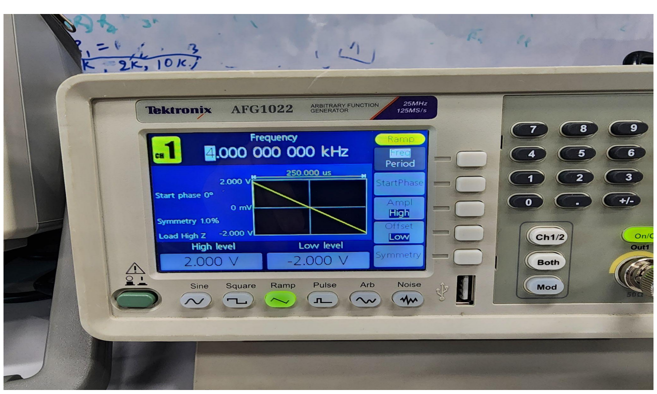



The above pattern is obtained by

- Both ramp wave
- Amplitude in 1:1
- Frequncy in 2:1
- Phase difference of 198°
- Symmetry at 50%


Agilent Technologies
DSO3062A
DIGITAL STORAGE OSCILLOSCOPE
60 MHz
1 GSa/s
MENU ON/OFF
RUN
X-Y Mode
AUTO
CH1 2.00V/
CH2 2.00V/
1.00MSa/s
Main Delayed
Measure
Cursors
Measure
Waveform
Acquire
Display
Vertical
Math
Ref
1
2


Tektronix AFG1022
Start phase
High level
Low level
2.000 V
-2.000 V
Sine
Square
Ramp
Pulse
Arb
Noise
Ch1/2
Both
Mod


Tektronix AFG1022
Frequency
4.000 000 000 kHz
Period
250.000 us
2.000 V
Start phase 0°
0 mV
Symmetry 1.0%
Load High Z
-2.000 V
High level
Low level
2.000 V
-2.000 V
Sine
Square
Ramp
Pulse
Arb
Noise
Ch1/2
Both
Mod

The above pattern is obtained by

- Both
- Amplitude in 1:1
- Frequncy in 1:2
- Phase difference of 65°
- Symmetry of one at 50% and other at 1%

Question for extra marks:

Advanced (extra marks): Not taking phone snapshots: extracting the
stored data from USB/other port and plotting the data in GNUplot/Origin. Event based triggering. Math function, FFT, digital filtering (?)

Answers:

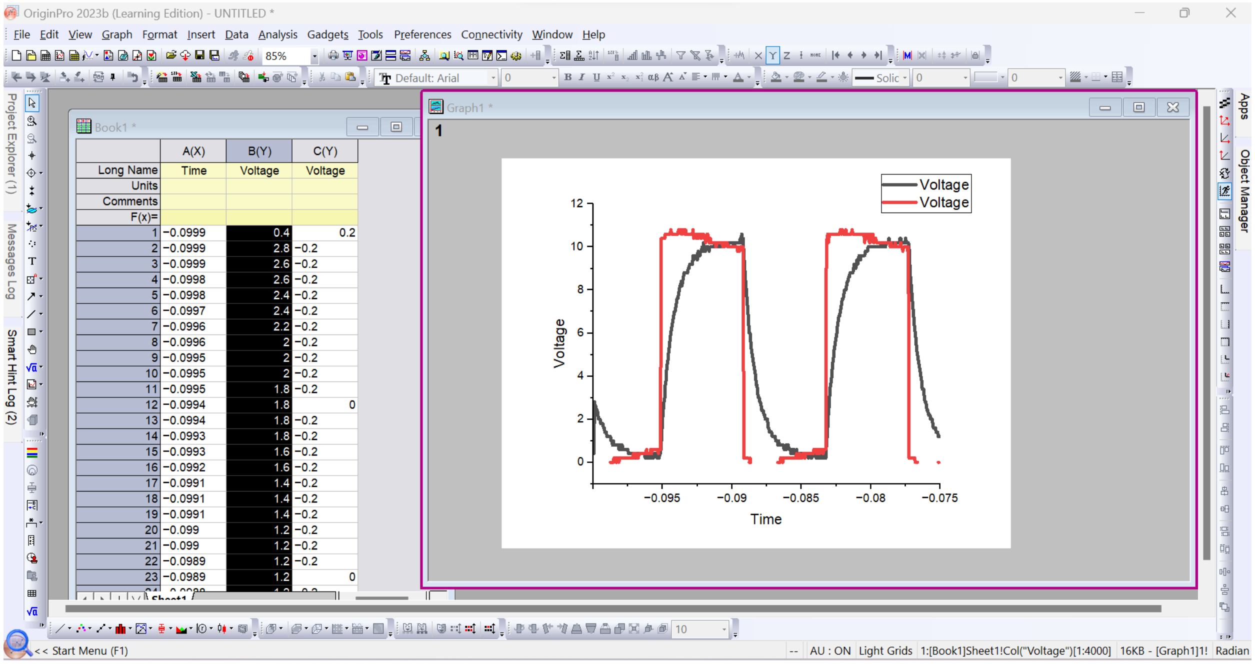
**Event based triggering:** single mode capture in DSO3062A

**Math functions**: it is used to do arithmetic operations on signal like add, subtract,multiply.It also includes FFT.

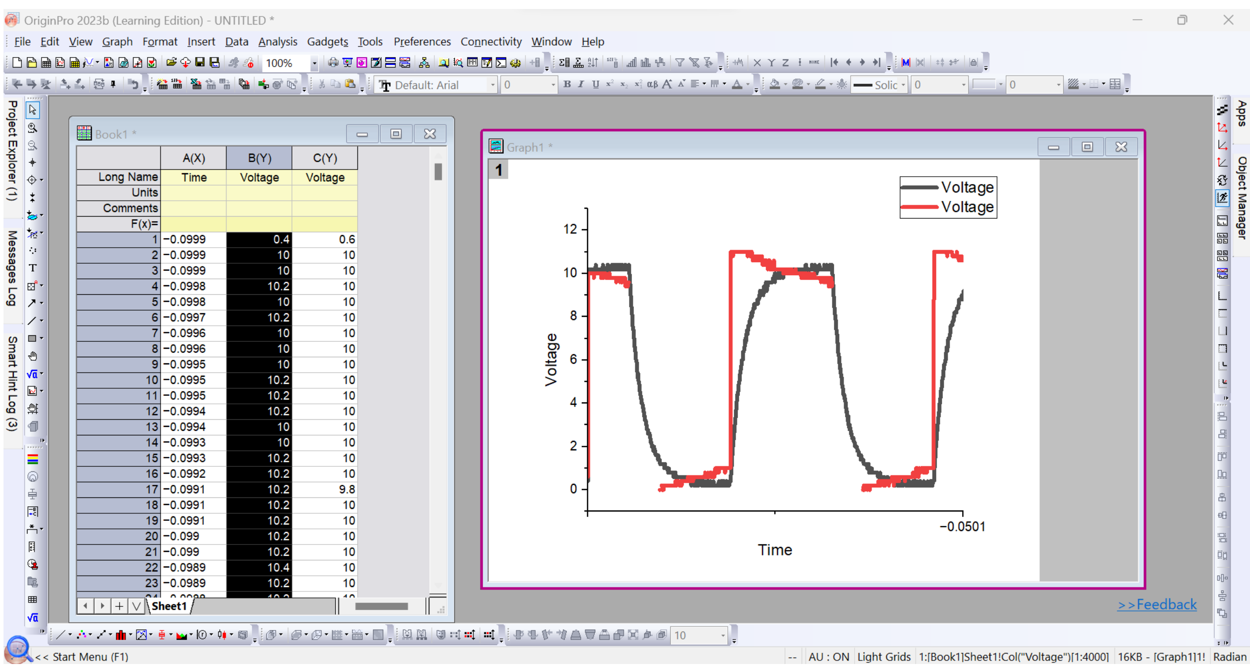
**FFT**:it stands for fast fourier transform, it convert time domain signal into frequency domain signal.

**Digital filtering:**it is feature to filter signal in DSO3062A ,it has low pass,high pass and band pass options

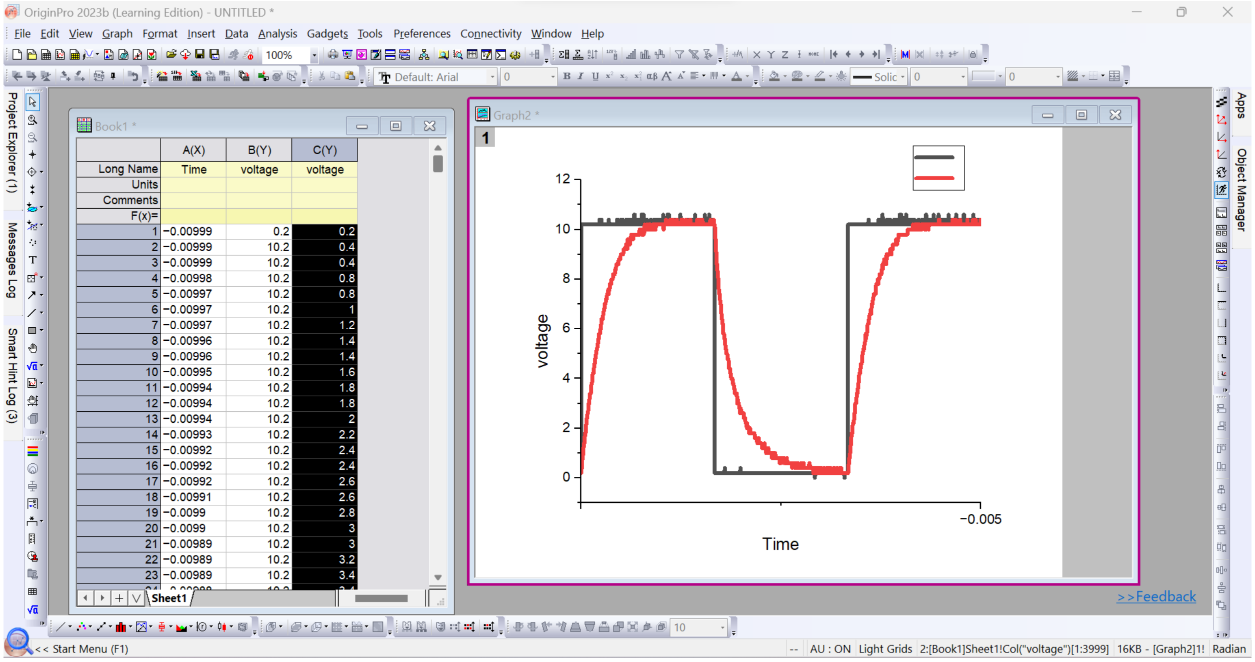
The data extracted for Q2b is plotted on origin:



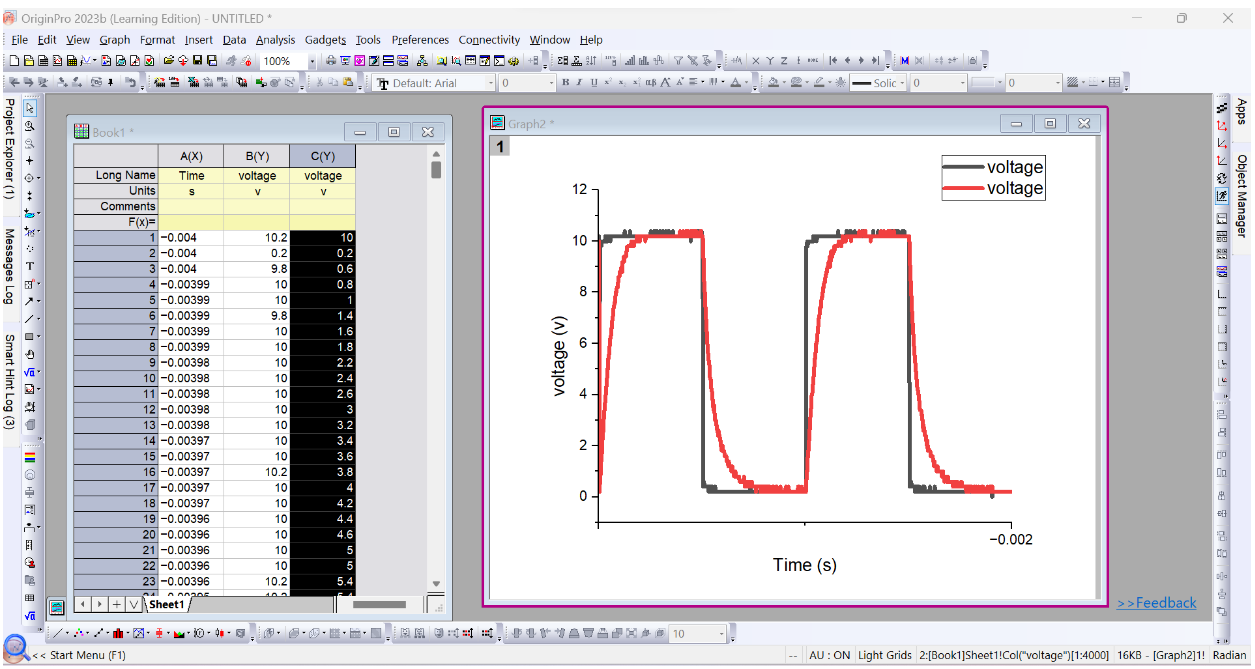
1k_1m



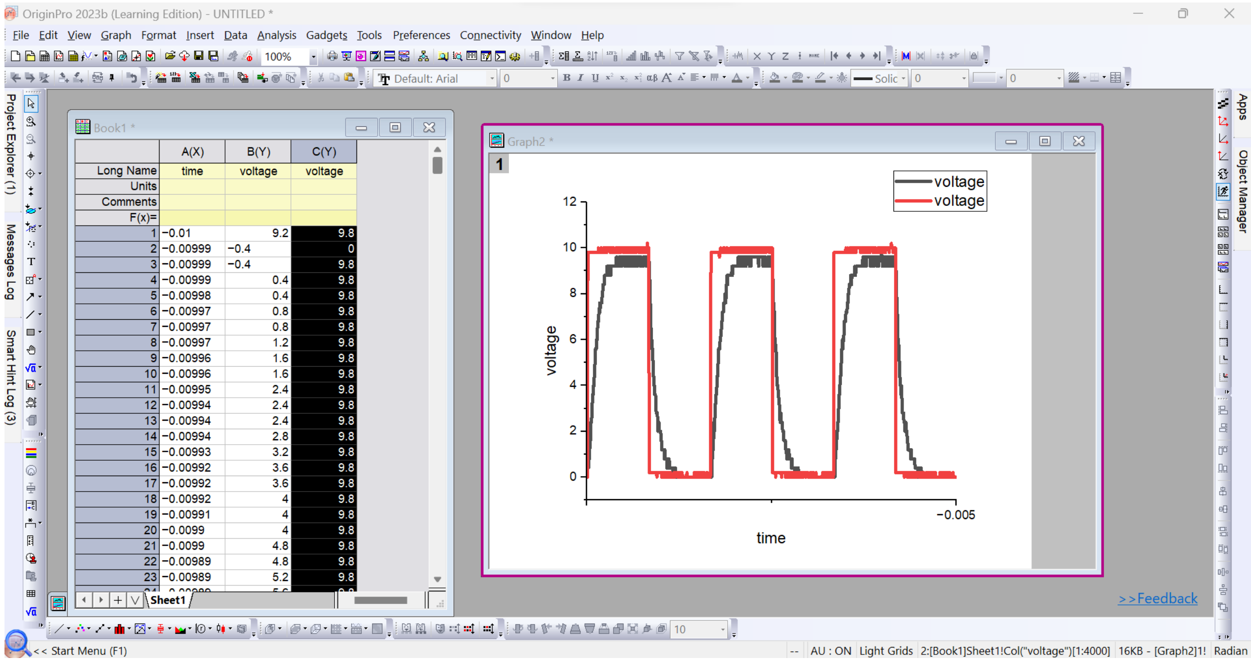
2k_1m



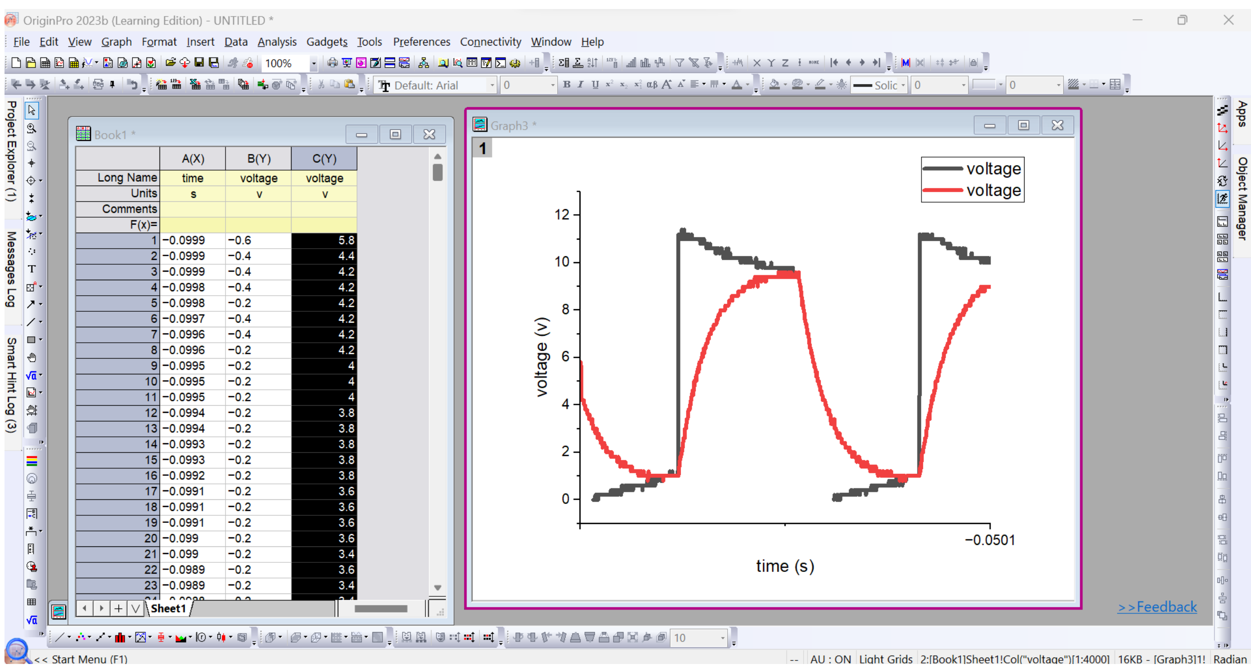

4.7k_1m




1k_100n




2k_100n




4.7k_100n