Certificate

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This is certified to be the bonafide work of the student in the .... Laboratory during the academic year 20 24 / 20 25

Number of practicals certified .... out of ....

in the subject of ECE101

Examiner's Signature

Teacher In-charge

Principal

Date:

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(N.B: The candidate is expected to retain his/her journal till he/she passes in the subject.)

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Experiment-1
(Familiarization with basic test equipment)

Objective

Familiarization with basic test equipment which will be used throughout the course.

Apparatus Required

DSO, DC Power Supply, Digital Multimeter, bread board, ~~wires~~ BNC cables

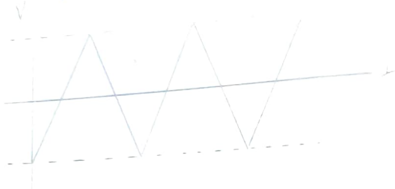
Theory

i) DSO (Digital storage oscilloscope):
An oscilloscope is an instrument used to produce a display of the two signals applied to the 2 channels (denoted by CH1 & CH2) and analyse the waveform of electronic signals.
It has 2 modes:-
- Y-t mode (Voltage vs time)
- X-Y mode (CH2 voltage vs CH1 voltage)

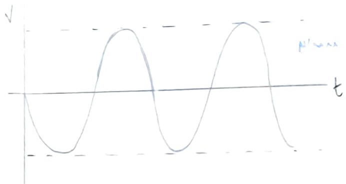
ii) Digital Voltmeter:
It is used to measure AC & DC voltages & it displays the result digitally.

iii) Function Generator (Wavegen):
It generates various waveforms like sine, square, triangular etc. with these parameters - frequency, amplitude, DC offset.
It provides test signals for the oscilloscope.

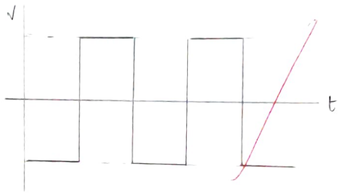
Waveform - Ramp / triangular



Waveform - Sine



Waveform - Square



iv) BNC cables:
These are coaxial cables used for transmission of electrical signals b/w the oscilloscope and function generator.

v) Breadboard:
It is used for prototyping electronic circuits.

Observations

1) We set the following settings of the wavegen:-
Waveform - Sinusoidal
Frequency - 1kHz
Amplitude - 4V p-p
DC offset - zero

We observe the signal waveform and note down their types.

2) Trigger Settings

Trigger	Run position	Stop position
Auto	Unstable	Frozen
Normal	Frozen	Frozen

3) Measure the peak to peak value of voltage and frequency of the Wavegen output at DSO by the 3 different methods.

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i) Method-1: By manually counting no. of divisions along horizontal, vertical axis.

$V_{max} = 2 \times 1V = 2V$

$V_{min} = -2 \times 1V = -2V$

$V_{pp} = 4 \times 1V = 4V$

Time Period = $5 \times 200\,\mu s = 1ms$

Freq. = $1/1ms = 1kHz$

ii) Method-2: Measuring by using cursors along vertical, horizontal axis

iii) Method-3: By using measurement feature to get direct digital readouts.

Method	V_{max}	V_{min}	$V_{max}-V_{min}$	V_{pp}	Time Period	Frequency
i)	2V	-2V	4V	4V	1 ms	1 KHz
ii)	2.1375V	-1.9875V	4.125V	4.0875V	1.018ms	982.32 Hz
iii)	1.95V	-2.15V	4.1V	4.1V	999.96 µs	1KHz

4) DC Power Supply & Multimeter

	Voltage Sources Channel	Company Name	Type	Voltage Range (Display of power supply)		Voltage Range (multimeter Readings)		Current Rating on
				V_{max}	V_{min}	V_{max}	V_{min}	
(A)	1	Scientific	Variable	32.1V	30V	32.4V	30.4V	2A
(C)	2	Scientific	Variable	5.8V	4.4V	5.79V	4.42V	5A
(B)	3	Scientific	Dual, Variable	15.8V	0V	15.81V	0.005V	1A
				15.7V	0V	-15.8[illegible]V	-0.006V	

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Conclusion

We could familiarise ourselves with the basic test equipments through this experiment.

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Experiment - 2

(Characteristics of Common Passive Devices)

Objective

To obtain the I-V characteristics of common passive devices on the DSO.

Apparatus Required

i) Resistors
ii) LDR
iii) Thermistors
iv) Different types of diodes
v) Capacitors
vi) DSO
vii) DC Power Supply
viii) Bread board
ix) BNC cables

Theory

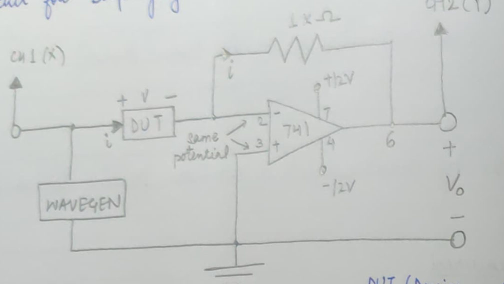
i) Resistors

→ They are usually classified according to composition, tolerance and power rating.

→ The resistor is coded by 3-4 coloured bands, 1st and 2nd giving significant digits and the last one giving the number of zeroes.

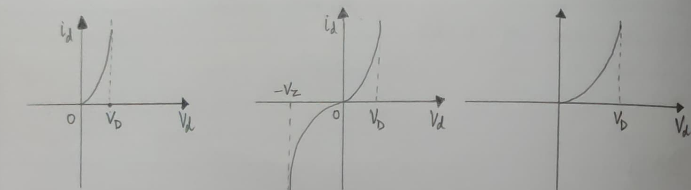
→ The ideal I-V characteristics of a linear resistor is a straight line passing through the origin and the slope gives the resistance.

Circuit for Displaying I-V Characteristics :



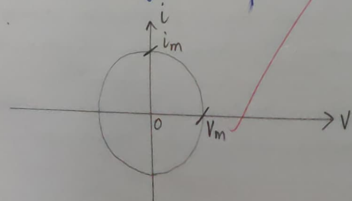
DUT (Device under test)

I-V Characteristics of different types of diodes:



Rectifier Diode　　Zener Diode　　LED

I-V characteristic pattern of Ideal Capacitor :



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ii) LDR and Thermistors :

→ The light dependent resistor is a linear resistor whose resistance decreases as illumination increases.

→ A thermistor is a linear resistor which has temperature dependent resistance. It is of 2 types - NTC & PTC.

iii) Diodes :

→ All diodes are non-linear resistors

→ The forward bias V_d is 0.5V - 0.6V for Rectifier diodes & zener diodes, while LED's of different colours have different values of V_d.

iv) Capacitors :

→ They are classified according to the dielectric material used in the fabrication of the capacitor and the range of values varies.

- Electrolytic - ($\geq 1\mu F$) - Cylindrical body with printed value & polarity indicated by +/-.

  Polyester - ($0.001 - 10\mu F$) - Moulded body with either printed or color coded.

  Ceramic - ($\leq 1\mu F$) - Disc shaped body with value printed on the body.

→ The ideal I-V characteristic graph of a capacitor is a circle, indicating 90° phase difference b/w current and voltage.

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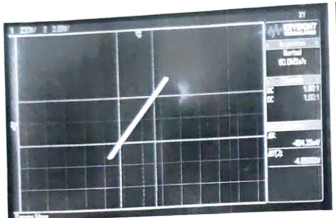
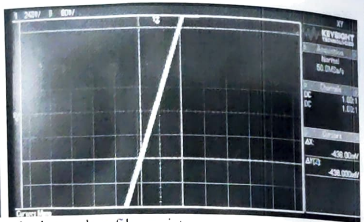
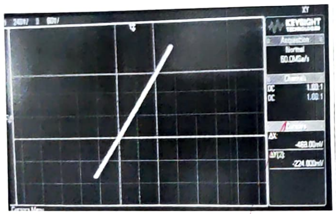


100 ohm wire wound resistor



1k-ohm carbon film resistor



2.2k-ohm carbon film resistor

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Observations & Calculations

[Freq. : 1kHz , Peak-to-Peak value = 1V , offset = 0V]

- Resistors

Shape of graph = straight line
slope / inclination = 45°

Component	V (Δx)	V_0 (Δy)	Calculated Value
i) 1/4 W 1% 1k-ohm carbon film resistor	438mV	438mV	1kΩ
ii) 1/2 W 5% 2.2k-ohm carbon film resistor	468mV	224mV	2.1 kΩ
iii) 5 W 100 ohm wire wound resistor	404.25mV	4.05 V	99.8Ω

$$\boxed{\text{Resistance} = \frac{\Delta X}{\Delta Y \times 10^{-3}}}$$

Calculations ⇒ i) $R_1 = \dfrac{438}{438 \times 10^{-3}} = 10^3 \Omega$

ii) $R = \dfrac{468}{224 \times 10^{-3}} = 2.1 \times 10^3 \Omega$

iii) $R = \dfrac{404.25}{4.05} = 99.8 \Omega$

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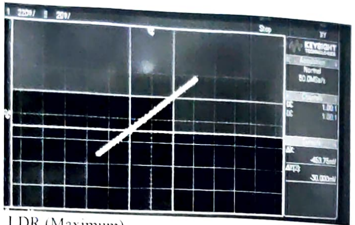
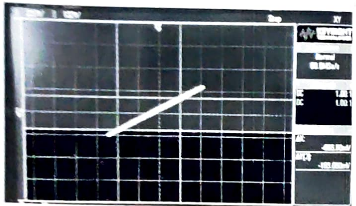
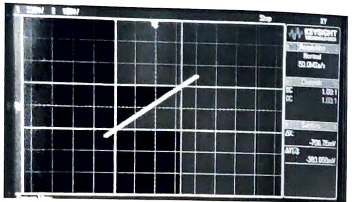


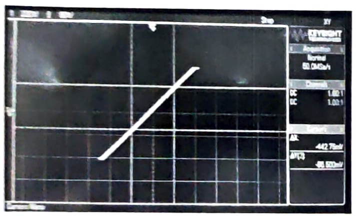
LDR (Maximum)



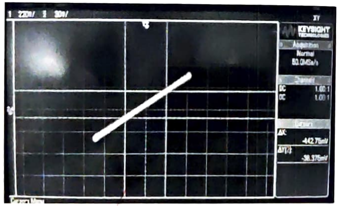
PTC Thermistor (Maximum Temperature)



PTC Thermistor (Minimum Temperature)



NTC Thermistor (Maximum Temperature)



NTC Thermistor (Minimum Temperature)

• LDR (Light Dependent Resistors)	V (Δx)	V_o (Δy)	Calculated Value
i) Maximum (Dark)	453.75mV	30mV	15.125kΩ
ii) Minimum	445.5mV	70.875mV	6.28kΩ

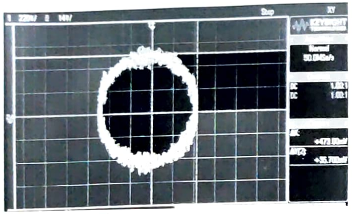
Calculations ⇒ i) Maximum $= \frac{V}{I} = \frac{453.75}{30 \times 10^{-3}} = 15.125\,k\Omega$

ii) Minimum $= \frac{V}{I} = \frac{445.5}{70.875 \times 10^{-3}} = 6.28\,k\Omega$

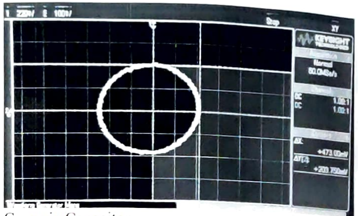
• Thermistors

shape of graph: straight line
slope / inclination : 45°

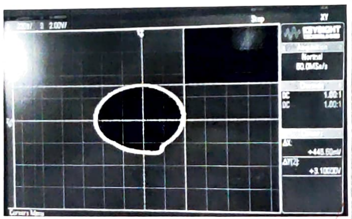
Components	V (Δx)	V_o (Δy)	Calculated Value
i) NTC Thermistor			
→ Maximum Temperature	442.75mV	95.5mV	0.0046 Ω
→ Room Temperature	442.75mV	36.75mV	0.012 Ω
ii) PTC Thermistor			
→ Maximum Temperature	665.5mV	193.05mV	0.0034 Ω
→ Room Temperature	706.75mV	383.05mV	0.0018 Ω



Polyester Capacitor



Ceramic Capacitor



Electrolytic Capacitor

• Capacitors

Shape of graph = circle
Frequency = 1KHz

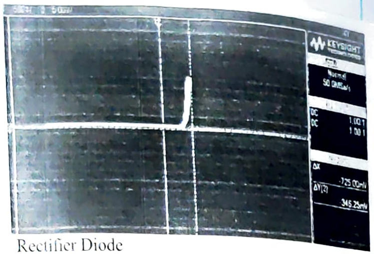
$$X_c = \frac{V_m}{I_m} \qquad C = \frac{1}{2\pi f X_c}$$

Component	V_m	I_m	X_c	C
i) 0.01 uF Polyester Capacitor	473 mV	35.7 mV	13.25	0.012 uF
ii) 0.1 uF Ceramic capacitor	473 mV	203.75 mV	2.32	0.08 uF
iii) 1 uF electrolytic capacitor	445.5 mV	3.1 V	0.14	1.1 uF

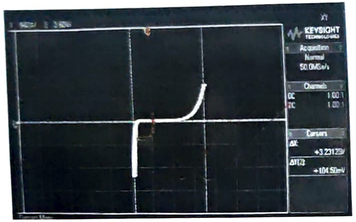
Calculations ⇒ i) $X_c = \frac{473}{35.7} = 13.25$ $\qquad C = \frac{1}{2\pi \times 1 \times 13.25} = 0.012\,uF$

ii) $X_c = \frac{473}{203.75} = 2.32$ $\qquad C = \frac{1}{2\pi \times 1 \times 2.32} = 0.08\,uF$

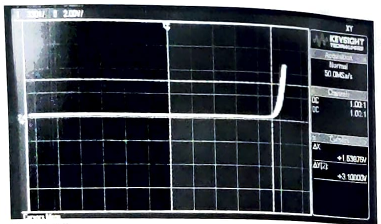
iii) $X_c = \frac{445.5}{3100} = 0.14$ $\qquad C = \frac{1}{2\pi \times 1 \times 0.14} = 1.1\,uF$



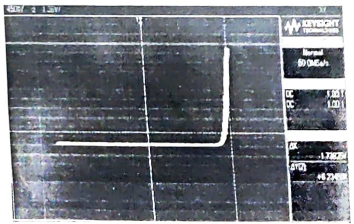
Rectifier Diode



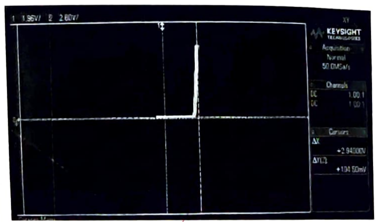
Zener Diode



Red LED



Green LED



White LED

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- Diodes

Peak to Peak value = 4V
offset : As necessary for each case

	Component	V_d	V_z
i)	Rectifier Diode	725mV	-
ii)	Zener Diode	1.23V	1.031 V
iii)	Red LED	1.538 V	-
iv)	Green LED	1.73825V	-
v)	White LED	2.94V	-

Conclusion

Observed V-I graphs of every component on DSO and calculated their ratings using the graph.
It almost matches the ratings on the component.

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Date 29/1/25

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Experiment-3

(Verification of Kirchoff's Law and Superposition Principle)

Objective

To learn how superposition can simplify the analysis of linear circuits.

Apparatus Required

i) Power Supply
ii) Breadboard
iii) Jumper Cables
iv) Capacitors
v) Inductors
vi) Resistors
vii) Multimeter

Theory

The superposition principle states that the response of the circuit to 2 voltage sources is given by the algebraic sum of the responses obtained from 2 seperate circuits obtained by keeping only one of the 2 sources and short circuiting the voltage sources.

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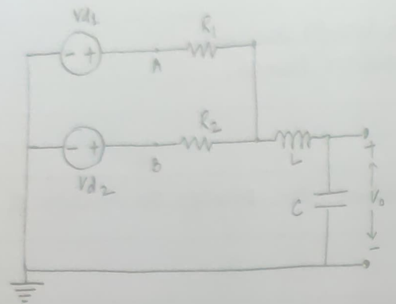
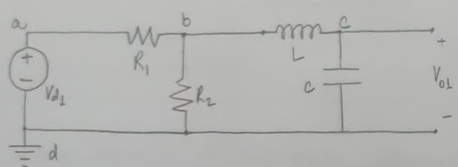
Circuit with 2 Independent DC Voltage Sources :

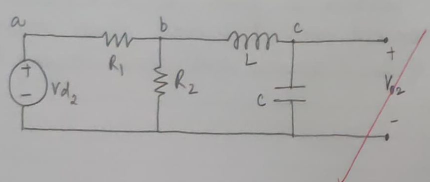


Equivalent Circuit for one Source

(a)



(b)



Observations

Table 1: (Both sources together)

V_{d_1} (DC source 1)	V_{d_2}	V_o
4 V	-3 V	0.511 V

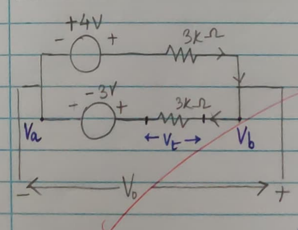
Table 2: (V_{d_1} only)

V_{d_1}	V_{d_2}	V_{o_1}
4 V	0 V	2.074 V

Table 3: (V_{d_2} only)

V_{d_1}	V_{d_2}	V_{o_2}
0 V	-3 V	-1.556 V

Calculations (Both sources together)



$+4 - 3kI - 3kI + 3 = 0$

$6kI = 7$ $\quad I = \frac{7}{6K}$ $\quad V_t = \frac{7}{6k} \times 3k$

$= 3.5\,V$

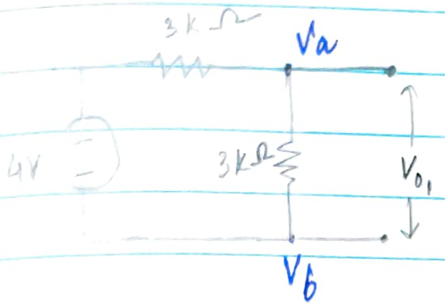
$V_o = \cancel{\frac{7}{6k} \times 3k}\ V_b - V_a$

$V_a - 3 + 3.5 = V_b \Rightarrow V_a - V_b = -0.5$

$V_o = 0.5$

(V_{d_1} only)

⇒ Capacitor behaves as an open circuit in case of DC power supply.



$V_a - V_b = V_{o_1}$

$4 - 3kI - 3kI = 0$

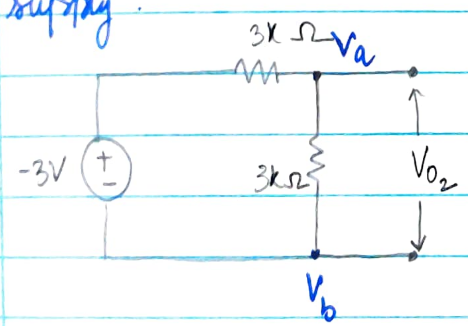
$I = \frac{4}{6k}$

$V_a + \left(\frac{-4}{\cancel{6}k_2} \times \cancel{3}k\right) = V_b$

$\Rightarrow V_a - V_b = 2V = V_{o_1}$

(V_{d_2} only)

⇒ Capacitor behaves as an open circuit in case of DC power supply.



$V_a - V_b = V_{o_2}$

$-3 - 3kI - 3kI = 0$

$I = \frac{-\cancel{3}}{2\cancel{6}k} = \frac{-1}{2k}$

$V_a - 3\cancel{k}\left(\frac{-1}{2\cancel{k}}\right) = V_b$

$V_a - V_b = \frac{-3}{2} = -1.5V$

$V_{o_2} = -1.5V$

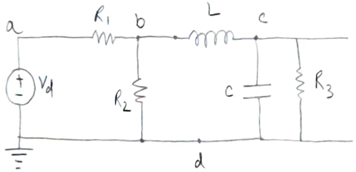


Fig.1

Conclusion

Table 4:

	V_{o_1}	V_{o_2}	V_o	$V_{o_1} + V_{o_2}$
Practical	2.074 V	-1.556V	0.511 V	0.518V
Theoretical	2V	-1.5 V	0.5 V	0.5V

** KCL & KVL Verification using DC Voltage Source

We modify the previous circuit and obtain a circuit as drawn. (Fig. 1)

Table 5:

V_{ab}	V_{bc}	V_{cd}	V_{db}	V_{da}
3.3V	0.001V	0.831V	-0.832V	-4.13V

verify for following loops:

i) $abcda = V_{ab} + V_{bc} + V_{cd} + V_{da} = 0$

$$3.3 + 0.001 + 0.831 + (-4.13) = 0.002$$

ii) $abda = V_{ab} + V_{bd} + V_{da} = 0$

$3.3 + 0.833 - 4.13 = 0.003$

iii) $bcda = V_{bc} + V_{cd} + V_{db} = 0$

$0.001 + 0.831 + (-0.832) = 0$

Table 6 :

I_{ab}	I_{bc}	$I(C)$	$I(R3)$	I_{bd}
1.093mA	0.812mA	0A	0.813mA	0.275mA

Verify for node B and node C :

i) node B : $I_{ab} = I_{bd} + I_{bc}$

$I_{ab} = 1.093\,mA$

$I_{bd} + I_{bc} = 0.812 + 0.275$

$= 1.087\,mA$

ii) node C : $I_{bc} = I(C) + I(R3)$

$I_{bc} = 0.812$

$I(C) + I(R3) = 0 + 0.813$

$= 0.813$

Conclusion

We have verified KCL and KVL with the above experiment.

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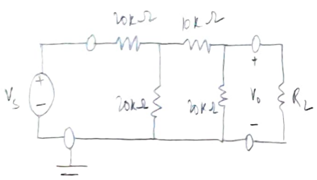
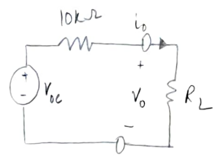


(a) Actual Circuit



(b) Thevenin Equivalent

Experiment - 4
(Thevenin's and Max^m Power Transfer Theorems)

Objective

To prove Thevenin's Theorem and maximum power transfer theorem.

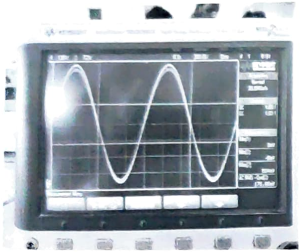
Apparatus Required

i) Breadboard
ii) Resistors of different values
iii) Jumpers
iv) Capacitor
v) Diode
vi) Multimeter
vii) DSO

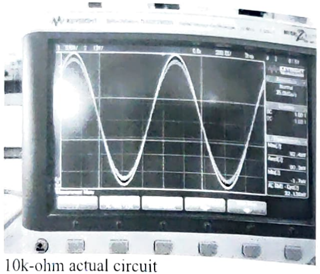
Theory

V_0 : open circuit voltage
I_{sc} : short circuit current

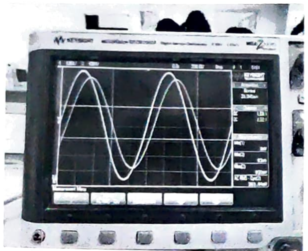
$$R_0 = R_{Th} = \frac{V_0}{I_{sc}}$$



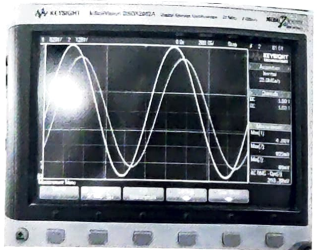
10k-ohm Thevenin circuit



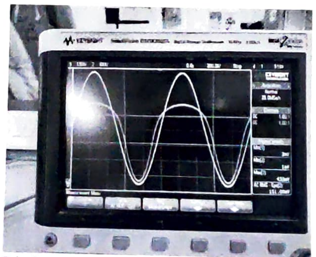
10k-ohm actual circuit



Capacitor Thevenin circuit



Capacitor actual circuit



Diode

Observations

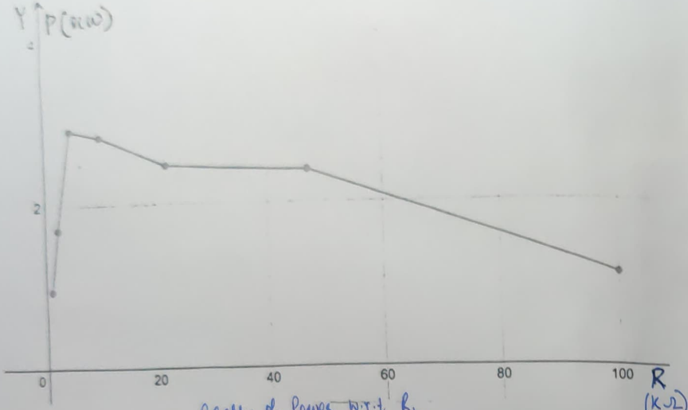
Measurement Table for Actual Circuit. (Table 1)

	Load Resistance (R_L)	V_0 (min.)	V_0 (max.)	V_0 (rms)	$i_0(rms) = V_0(rms)/R_L$	Power ($V_{rms} * i_{rms}$)
(i)	1kΩ	-1.7mV	92.4mV	32.136 mV	32.136 µA	1032.7×10^{-9}W
(ii)	2.2kΩ	-4mV	183mV	63.842mV	29.02 µA	1852.7×10^{-9}W
(iii)	4.7kΩ	-5mV	326mV	113.78 mV	24.21 µA	2754.61×10^{-9}W
(iv)	10kΩ	-1mV	508 mV	176.38mV	17.638 µA	3110.99×10^{-9}W
(v)	22kΩ	-2mV	693 mV	240.89 mV	10.95 µA	2637.74×10^{-9}W
(vi)	47kΩ	-3mV	840 mV	292.01 mV	6.213 µA	1814.26×10^{-9}W
(vii)	100kΩ	3mV	913 mV	317.64 mV	3.1764 µA	1008.95×10^{-9}W

Measurement Table: (Table 2)

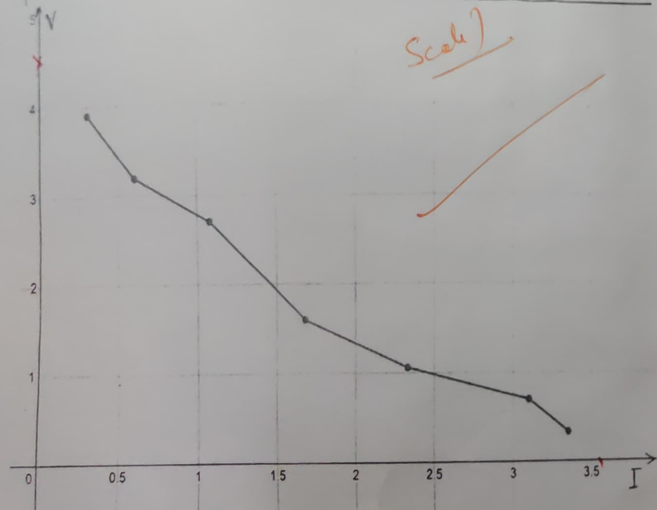
	Load	V_0(min)	V_0(max)	V_{RMS}
(i)	0.01µF Capacitor	89mV	922mV	243.38mV
(ii)	Diode	10mV	435mV	147.72mV

do not manipulate the table



Graph of Power w.r.t R_L

Scale: 1unit = 2.4W



Scale)

V-I Characteristic Graph

Measurement Table for Thevenin's Circuit: (Table 3)

Load	V_0 (min.)	V_0 (max.)	V_{RMS}	$I_{0(RMS)} = V_{0(RMS)}/R_L$	Power ($V_{RMS} * I_{RMS}$)
$R_L = 10k\Omega$	-5mV	504mV	175.96mV	17.596 ~~2.864~~ μA	3096.192×10^{-9} W
Capacitor	83mV	920mV	293.94mV	-	-
Diode	1mV	433mV	151.08mV	-	-

Conclusion

Comparing the value of $R = 10\Omega$ from Table 1 & Table 3:

Table 1: Power = 3110.99×10^{-9} W
Table 3: Power = 3096.192×10^{-9} W

$\therefore \boxed{P = P_{Th}}$

From Table 3, we can also conclude that max^m power is transferred when $R = 10\Omega$

$\Rightarrow \boxed{R = R_{Th}}$

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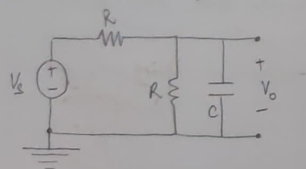
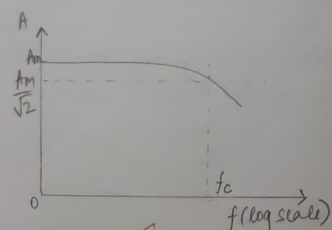
R=20kΩ, C=0.001μF



(a) Circuit diagram



(b) Frequency Response

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Experiment-5

(Transients in Capacitors and Common RC Filter Circuits)

Objective

Understanding common RC circuits and observing the transient behaviour in capacitor.

Apparatus Required

i) 10kΩ and 20kΩ resistors
ii) 0.001 μF Capacitors
iii) Jumpers
iv) DSO
v) Breadboard

Theory - LPF

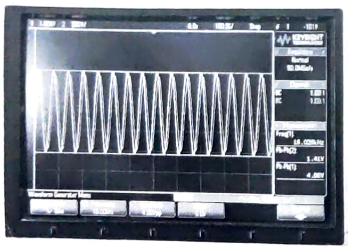
LOWPASS RC FILTER

Gain is maximum at low frequencies, & falls off beyond a cut-off frequency.

The Voltage Gain $A = V_s / V_0$.

A remains constant at a value A_m at low frequencies and falls off as frequency increases. The frequency f_c at which $A = \frac{A_m}{\sqrt{2}}$ is called cut-off frequency. The theoretically expected values are: $A_m = 0.5$ and $f_c = \frac{1}{\pi RC}$

Teacher's Signature



Sinewave - LPF

Observations & Calculations - LPF

Frequency = 100 Hz
Amplitude = 4V
offset = 0V

$A = \frac{V_s}{V_0}$ = slope of line in x-y mode

Here, $A_m = \frac{\Delta Y}{\Delta X} = \frac{1.15625}{2.35} = 0.492 \simeq 0.5$ ∴ Verified
$(A_{m(\text{practical})} \simeq A_{m(\text{theor.})})$

$\therefore \frac{A_m}{\sqrt{2}} = 0.3444$

Now, $\frac{V_0}{V_s} = \frac{A_m}{\sqrt{2}} \Rightarrow V_0 = 0.3444 \times 4$
$= 1.3776$ V pp

The frequency corresponding to $V_0 = 1.3776$ V pp is 16.026 kHz (f_c)

V_s	Gain A_m	f_0	f_c	B.W $(f_c - f_0)$
4V	0.492	8 kHz	16.026 kHz	8.026 kHz

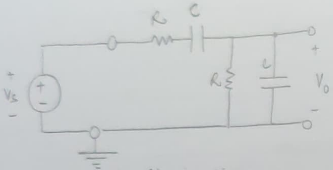
Theoretically,

$$f_c = \frac{1}{\pi RC} = \frac{1}{(3.14)(20\times10^3)(10^{-7})} = 15.98\ kHz \simeq 16\ kHz$$

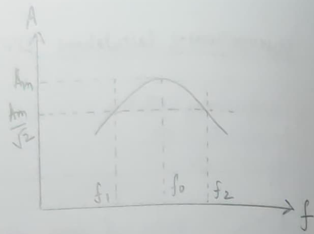
∴ Verified

$(f_{c(\text{practical})} = f_{c(\text{theor.})})$

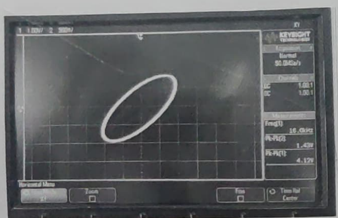
Teacher's Signature



(a) Circuit diagram



(b) Frequency Response



Initial Stage : ellipse - BPF

straight line - BPF

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Theory - BPF

BANDPASS RC FILTER

Gain falls off on either side of a centre frequency

Voltage Gain A has a max^m value A_m at centre frequency f_0, and falls off both at lower and higher frequencies.
The theoretical values of f_0 and voltage gain A_m at f_0 are given by:

$f_0 = \frac{1}{2\pi RC}$ and $A_m = \frac{1}{3}$

Observations & Calculations - BPF

The graph starts off as an ellipse in X-Y mode. We change the frequency till we obtain a straight line, indicating V_0 & V_s in same phase at $f_0 = 8.292$ kHz.

$A = \frac{V_0}{V_s}$ $\quad A_m = \frac{\Delta Y}{\Delta X} = \frac{691.50 \times 10^{-3}}{2.0625} = 0.3381$

$\frac{A_m}{\sqrt{2}} = 0.23626$ V

$\frac{V_0}{V_s} = \frac{A_m}{\sqrt{2}} \Rightarrow V_0 = 0.2367 \times 4$

$= 0.9468$ V pp.

$V_{0\,(prac)} = 0.9468$ V pp.

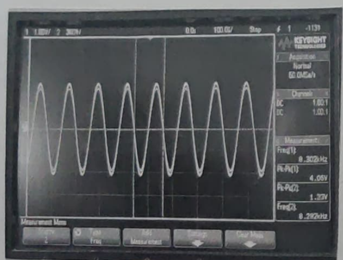
Teacher's Signature ____________

10 kΩ resistor

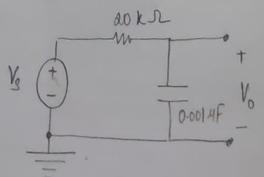
$\tau = RC$

$\tau = 10^{-5} s = 10\mu s$

Charging (τ)	Freq.	Amp.	V_0 at τ	2τ	3τ	5τ
10 μs	1 kHz	4V	2.425 V	3.3V	3.66 V	3.8125 V
Discharging (τ)	Freq.	Amp.	V_0 at τ	2τ	3τ	5τ
10 μs	1 kHz	4V	1.4125 V	462.5mV	150mV	0V



Sinusoidal wave



V_s	Gain A_m	$f_{0(prac)}$	f_{c_1}	f_{c_2}	B.W($f_{c_2} - f_{c_1}$)
4V	0.3381	8.292 KHz	2.5KHz	28KHz	25.5 KHz

Theoretically,

① $A_m = \frac{V_0}{V_S}$

$\Rightarrow V_0 = \frac{1 \times 4}{\frac{3}{\sqrt{2}}} = 0.933 \simeq 0.94V$ $\quad V_{0(theor.)} = 0.94$ V p-p

$V_{0(prac.)} \simeq V_{0(theor.)}$ ∴ Verified

② $f_0^2 = f_1 f_2$

$f_0^2 = (8.292)^2 = 68.75$ $\quad f_1 f_2 = 70$

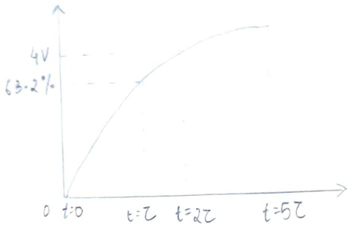
$f_0^2 \simeq f_1 f_2$ ∴ Verified

③ $f_0 = \frac{1}{2\pi RC} = \frac{1}{2(3.14) \times 20 \times 10^3 \times 10^{-3}} = 7.95$ KHz $\quad f_{0(theor.)} = 7.95$ KHz

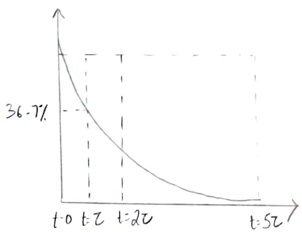
$f_{0(prac.)} \simeq f_{0(theor.)}$ ∴ Verified

Theory - Transients in Capacitors

Observe the transient behaviour in capacitor using square wave. Implement the given circuit. Generate square wave voltage (at 1KHz) V_s = 4V with Min. 0 to Max. 4V using desired offset through function generator (Wavegen).



Charging



Discharging

Observations

Charging and Discharging Observations:

Charging:

$\tau = R \times C$	Applied freq.	V_0 (t=0)	V_0 (t=τ)	V_0 (t=2τ)	V_0 (t=5τ)	V_s
20μs	1 kHz	25mV	2.5V	3.425V	3.9125V	4V

Discharging:

$\tau = R \times C$	Applied freq.	V_0 (t=0)	V_0 (t=τ)	V_0 (t=2τ)	V_0 (t=5τ)	V_s
20μs	1 kHz	3.95V	1.425V	550mV	125mV	4V

Conclusion

We understood common RC circuits and observed the transient behaviour in capacitor.

τ = 10 μsec)
R = 10 kΩ)
Incomplete curve → on blank page of previous page

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