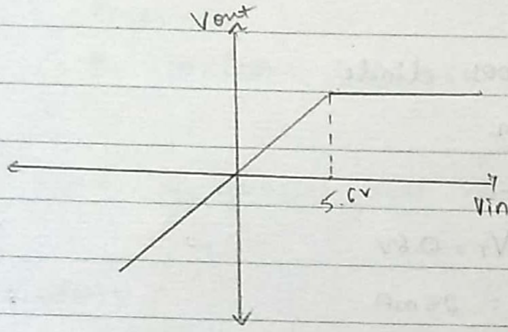
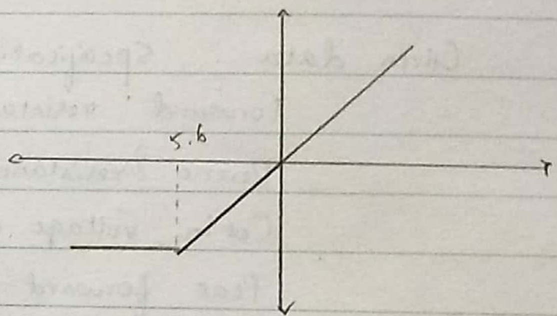
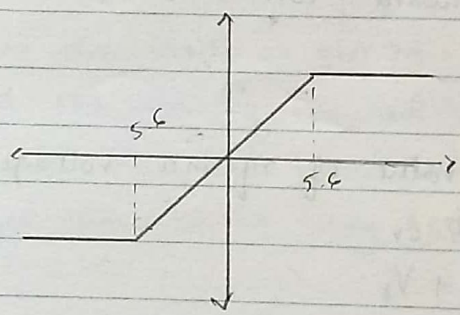
Experiment no: 1

Title: Design and testing of diode clipping circuits.

Aim: To design suitable diode clipping circuits for the transfer characterstics using IN4001 diode with peak current ≤ 20mA and input signal will be $V_s = 8\sin(2\pi \times 10^3 t)$ volts.







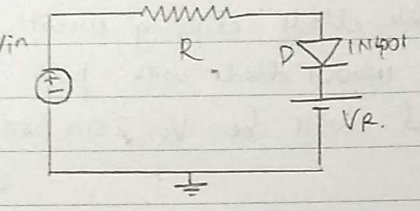
List of components.

Sl No	Components	Specification	Quantity
1	Diodes	IN4001	02
2	Resistor	1kΩ	01
3	AFO	3MHz, 20$V_{p\text{-}p}$	01
4	CRO	20MHz, 70V_{pp}	01
5	DC power supply	0.3V, 2A	01
6	BNC's	--	03

Formula Required | Design :

Positive clipper :

The transfer characteristics in first figure is of positive clipper and circuit is



Given data : Specification of 1N4001 diode

Forward resistance $R_f = 0\Omega$

Reverse resistance $R_r = \infty$

Cut in voltage of diode $V_r = 0.6V$

Peak forward current $I = 25mA$

Steps :

1) Calculate the value of reference voltage V_R

wkt $V_s = 5.6V$

$V_s = V_R + V_r$

$V_R = V_s - V_r = 5.6 - 0.6 = 5V$

2) Compute value of R required.

by KVL we have

$V_{s(t)} = I_s(t) R + V_r + V_R$

under maximum conditions

$V_m = I_m R + V_r + V_R$

$8 = 2.5m \times R + 0.6 + 5$

$R = \frac{8 - 5.6}{2.5} K\Omega = 0.96 K\Omega$

Standard value of resistor near to 0.96 is $1K\Omega$

3) To decide the wattage of resistor, first we have to calculate power.

$$P_{D(R)} = \frac{I_m^2 R}{2} = \frac{(2.5\times10^{-3})^2 \times 10^3}{2}$$

$$P_{D(R)} = 3.125 mW$$

4) Power rating of resistor should be 10 times larger than $P_{D(R)}$

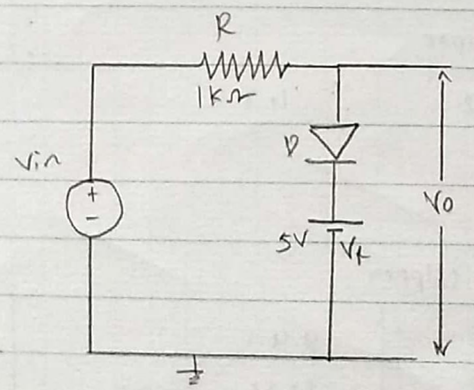
$P = 10 \times P_{D(R)} = 0.03125W.$

Hence a quarter watt resistor can be used.

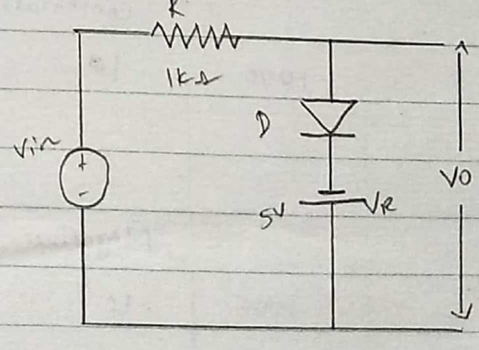
Procedure:

- The circuit connections are made as shown.
- For each circuit a sine wave of required amplitude & frequency has to be given and output is traced using CRO.
- Observe the transfer characterstics using CRO.

Circuit Diagram



Positive clipper



Negative clipper.

Combination Clipper

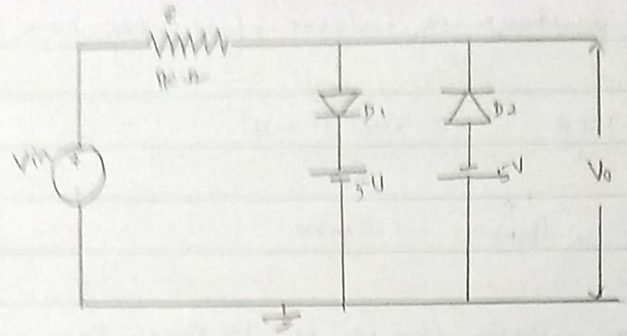


Table of observation

Sl No	Vref = VR in V	Frequency in Hz	Vin p-p in V	Vo p-p in V	Clipped portion Vinp-p - Vop-p in V
			Positive unbiased clipper		
1	0	1000	16	8.6	7.4
			Negative unbiased clipper.		
1	0	1000	16	8.6	7.4.
			Positive biased clipper		
1	5	1000	16	13.6	2.4
2	-5	1000	16	3.6	12.4
			Combinational clipper		
1	5	1000	16	11.2	4.8
			Negative biased clipper		
1	5	1000	16	13.6	2.4
2.	-5	1000	16	3.6	12.4.

EXPERIMENT NO. :

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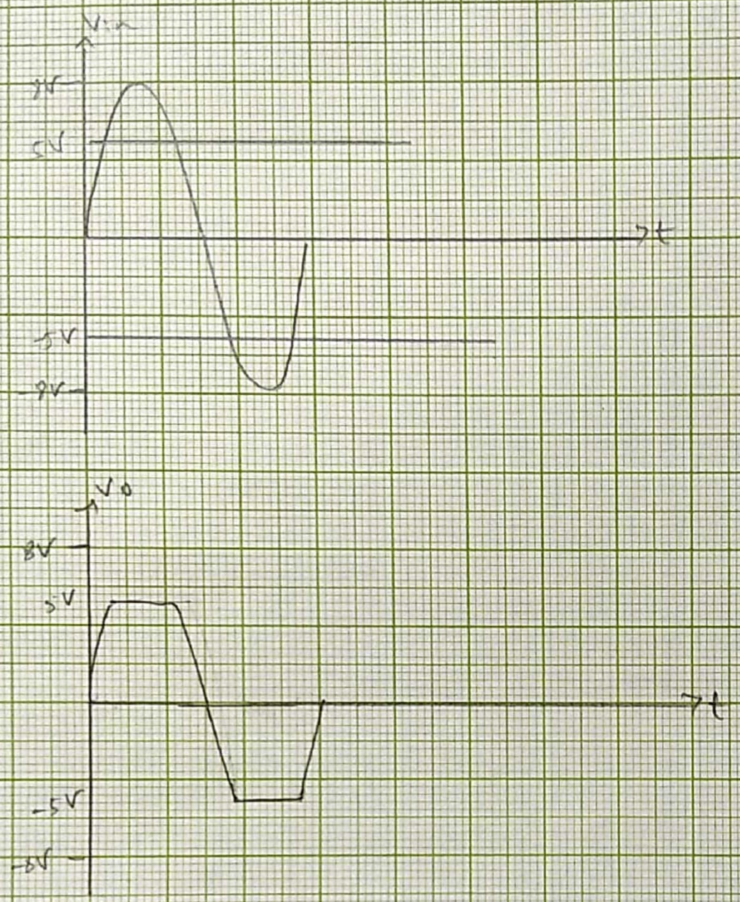
SCALE : X - axis :

Y - axis :

combinational clipper



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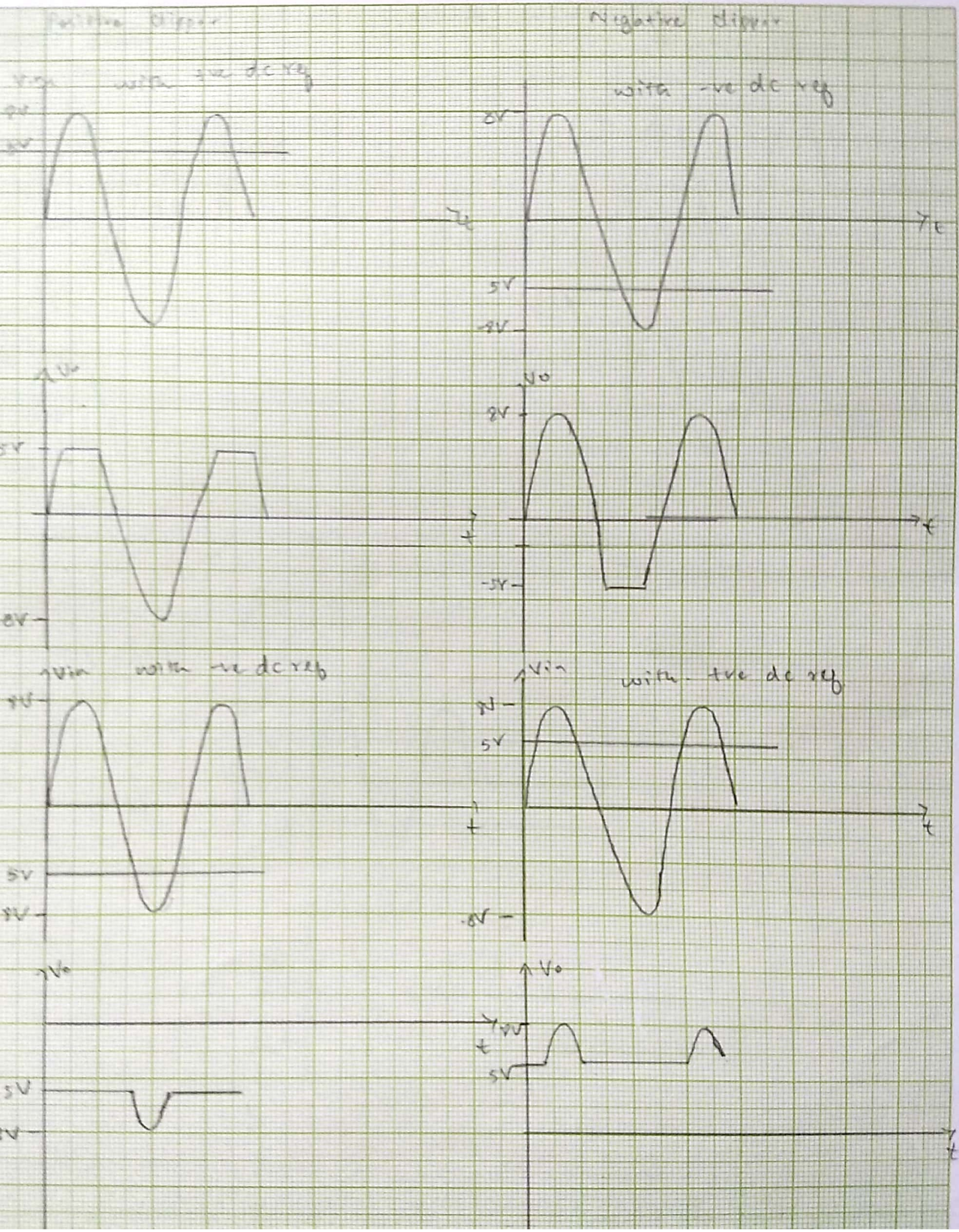
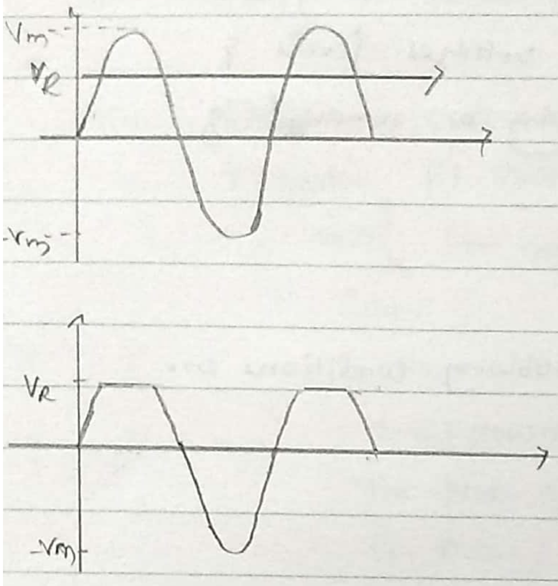
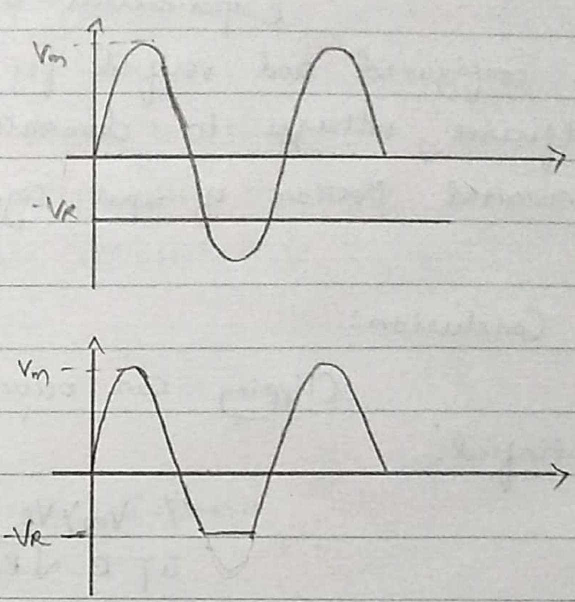


Nature of graph:

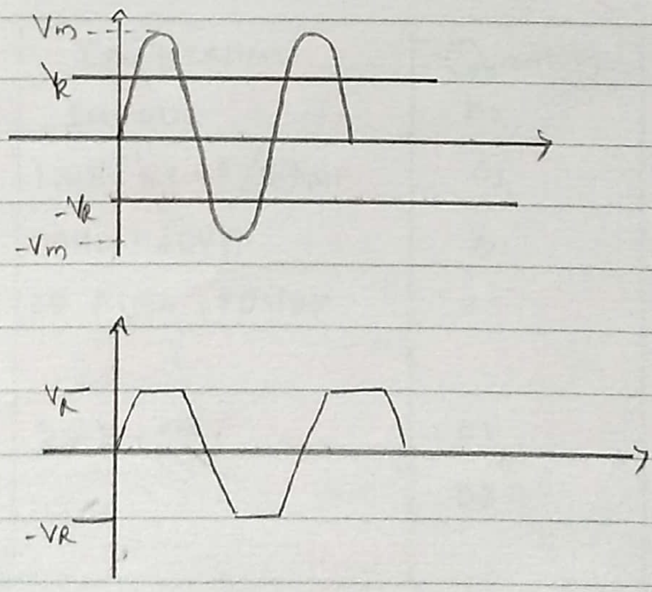
Positive clipper



Negative clipper



Combinational Clipper



Conclusion of experiment

Result & Discussion

Experimental setup for clipping circuit using diode is configured and verified for different input voltages levels & reference voltages to demonstrate the clipping or removal of unwanted portion of input signal.

Conclusion:

Clipping can occur only when following conditions are satisfied.

i) $V_m > V_R$

ii) $R = \sqrt{R_f R_r}$

Experiment no :

Title : Design and testing of diode clamping circuits.

Aim : Design a suitable circuit using diode to clamp i) negative ii) Positive extremety of a periodic signal to zero volts . For input $V_s(t) = 5\sin(2\pi \times 10^5 t)$ V.

Given
diode 1N4001
Breakdown voltage = 50V
The peak representative current ≤ 100mA
$R_f = 0\Omega$
$R_r = \infty$
$V_r = 0.6V$

List of components :

Sl No	Components	Specification	Quantity	Cost per Item
1	Diodes	1N4001	02	2
2	Capacitors	1μF / 0.1μF / 4.7μF	01	5
3	AFO	1MHz , 20Vpp	01	10,000
4	CRO	20 MHz , 80Vpp	01	25,000
5				
5	Power supply	30V , 2A	01	4 000
6	BNC's		03	150

Design:

Maximum current $I_{max} = 1A$

Maximum peak current $I_{peak} = 20A$

Breakdown voltage : 50V

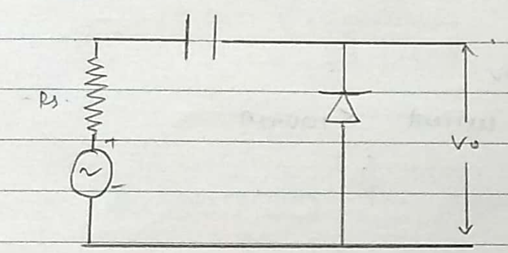
Large signal parameter $V_r = 0.6V$

$R_f = 0\Omega$

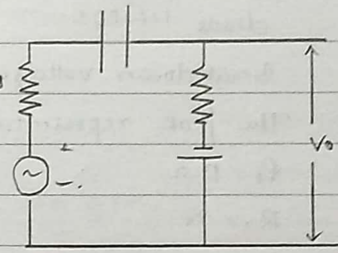
$R_r = \infty\Omega$

Input signal $V_s = 5\sin(2\pi \times 10^3 t)$ volts.

Output voltage $V_o = 2V_m$.



Positive clamper circuit



Equivalent ckt when diode is forward biased.

Design steps :

1) Compute the value of capacitor C

Replace diode with equivalent circuit when diode is forward biased, then applying theorems wkt

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{(R_s + R_f)^2 + \left(\frac{1}{C\omega}\right)^2}$$

2) Applying KVL to ckt

$$V_s(t) = I_s(t)\, Z - V_r$$

Since $V_r <= V_s(t)$

$$V_s(t) = I_s(t) \sqrt{(R_f + R_s)^2 + (X_c)^2}$$

under max condition

$$V_m = I_m \sqrt{(R_f + R_s)^2 + X_c^2}$$

$$I_m = \frac{V_m}{\sqrt{(R_f+R_s)^2 + X_c^2}} \leq 100mA$$

4) Consider forward resistance of diode R_f & internal resistance of generator R_s to be very small & neglect them.

$$I_m = \frac{V_m}{\sqrt{(1/C\omega)^2}}, \quad V_m C\omega \leq 100mA$$

5) Rearranging the equation we get

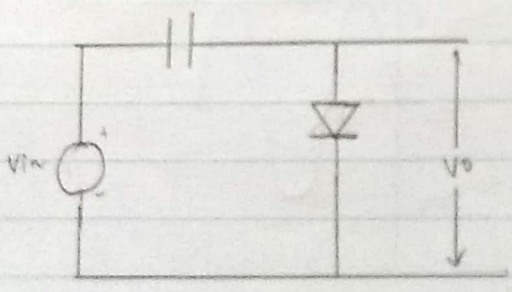
$$C = \frac{I_m}{V_m \omega} = \frac{100}{5 \times 2\pi \times 10^3} = 3.18\mu F$$

6) The nearest standard capacitor value is $4.7\mu F$

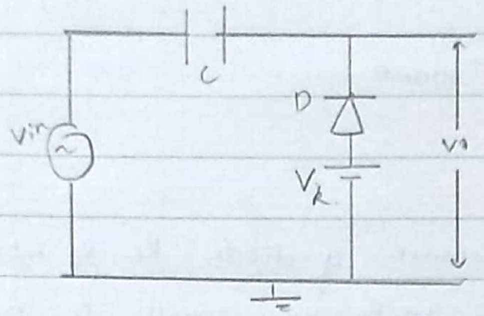
7) In order to find the PIV rating of the diode consider the case when diode is not conducting ie during the positive half cycle hence

PIV $= 2V_m = 10V$, it should be less than breakdown voltage.

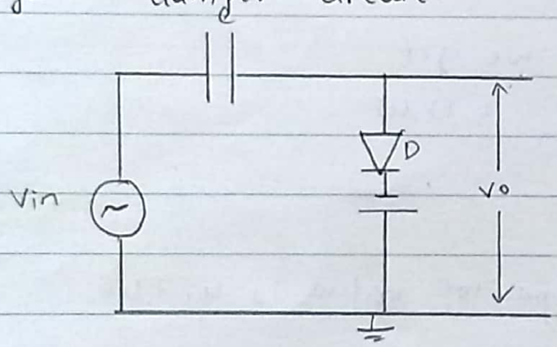
8) Hence Capacitor voltage rating may be 10V.



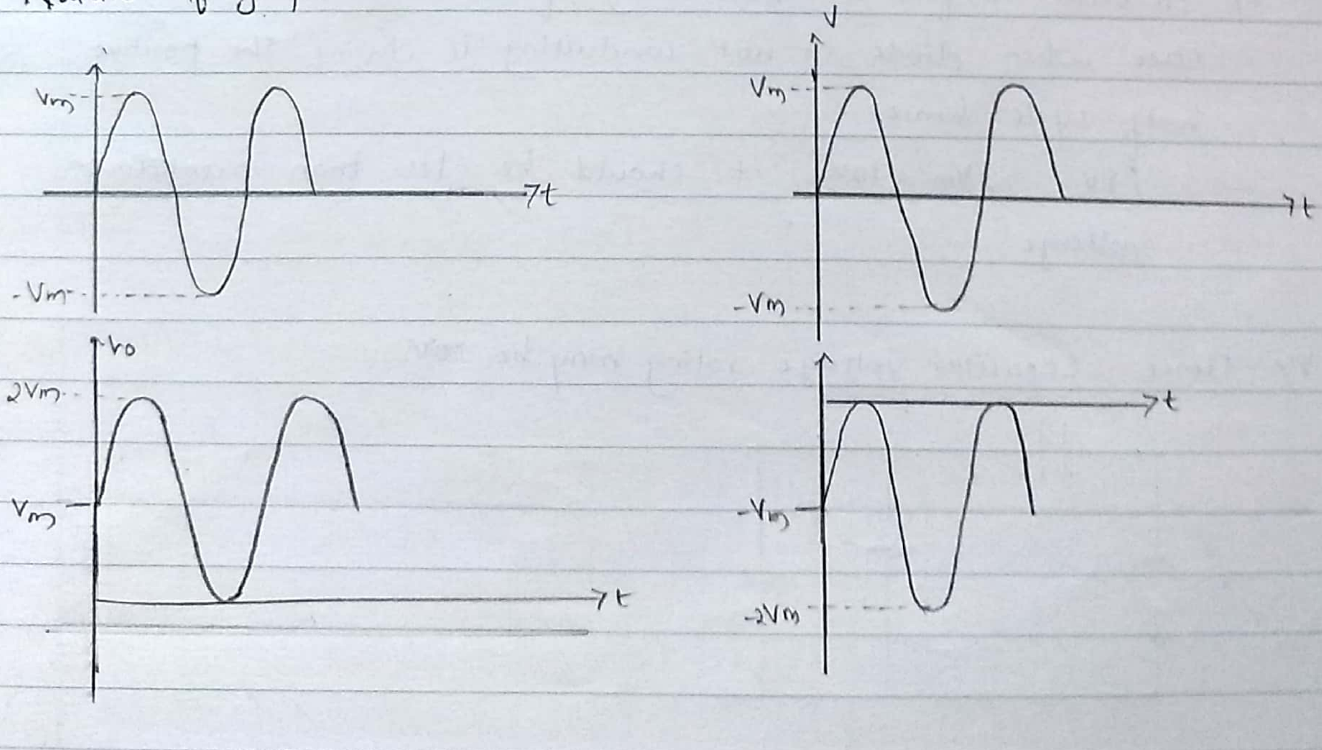
i) Positive biased clamper



ii) Negative clamper circuit.



Nature of graph



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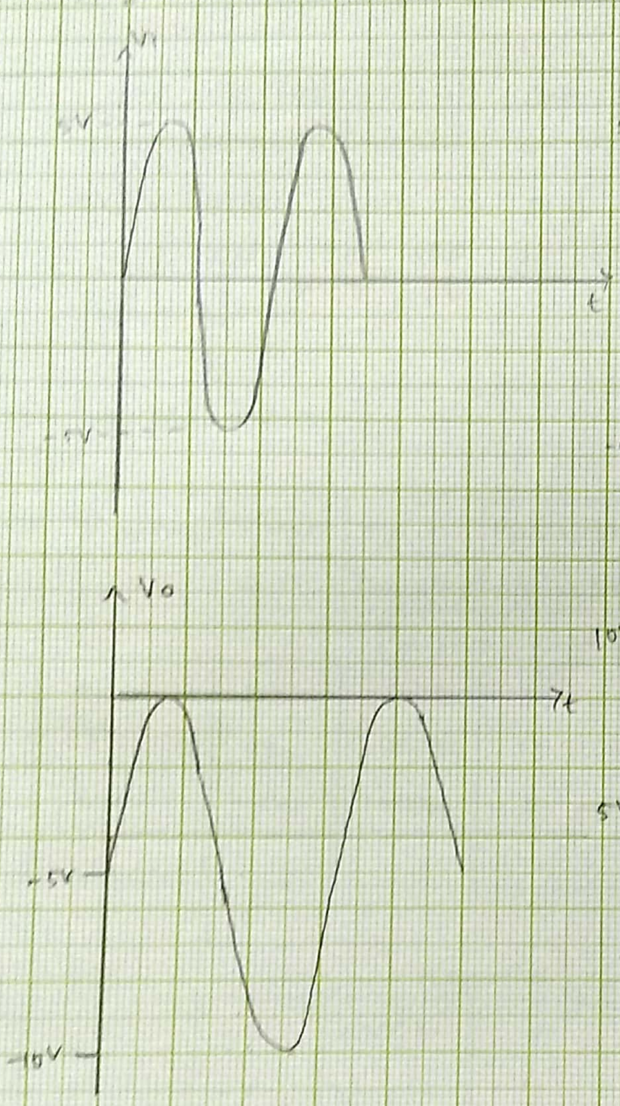
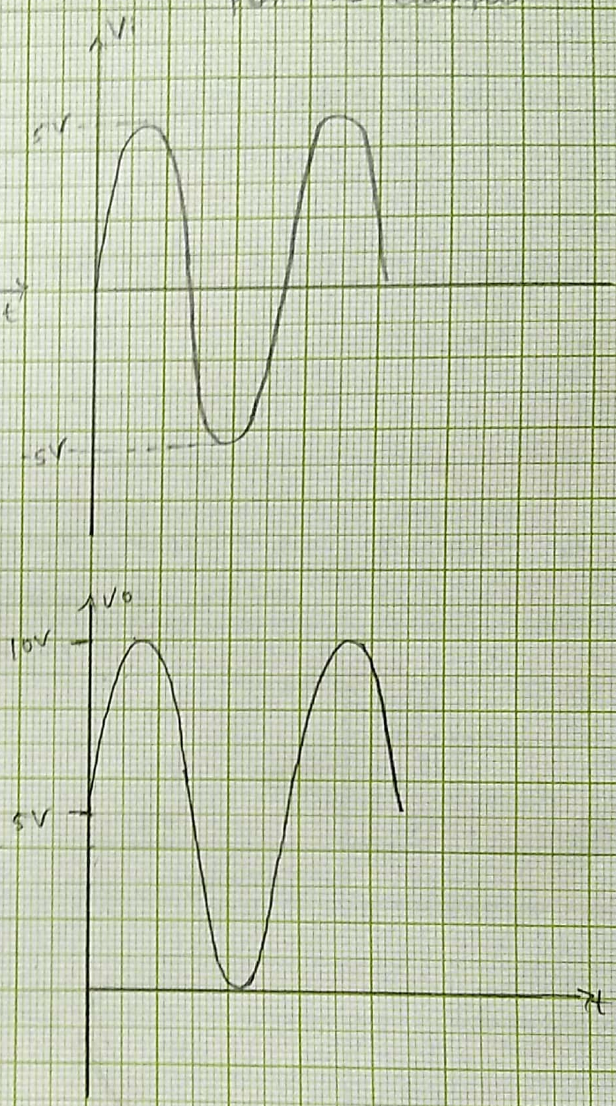
Negative clamper



Positive clamper



Procedure:

1) The circuit connections are made as shown in the circuit diagram.

2) For each circuit give a sine wave input of desired amplitude and frequency as input is shown and note down output wave form as seen in CRO.

3) Keep the CRO on DC mode to observe the output wave form.

Table of observation:

Sl No	i/p voltage	V ref in Volts	i/p frequency	Positive peak o/p voltage	Negative peak o/p voltage	Average o/p Voltage
			Positive clampes			
1	5V	0V	1000hz	10	0V	5V
2	5V	2V	1000hz	12	2V	7V
3	5V	-2V	1000hz	8	-2V	3V
			Negative clamper			
1	5V	0V	1000hz	0	-10	-5
2	5V	2V	1000hz	-2	-12	-7
3	5V	-2V	1000hz	2	-8	-3

Experiment no:

Title: Realization of BJT as a switch.

Aim: Design a switch using BJT with following specifications

i) $\beta = 50 - 150$

ii) Overdrive factor $= 10$

iii) $V_{CC} = 5V$

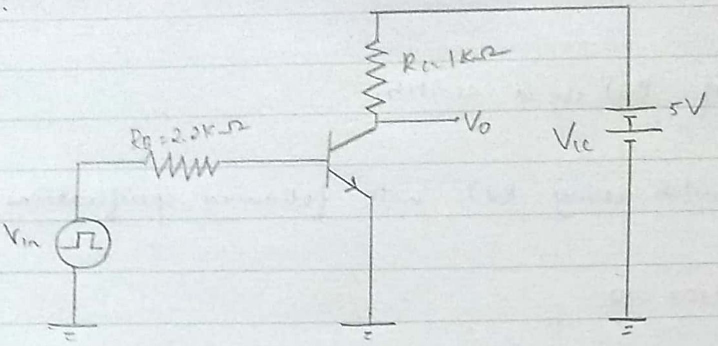
iv) $R_C = 1K\Omega$

v) $V_{CEsat} = 0.2V$

List of components.

Sl No	Components	Specification	Quantity
1)	BJT	2N2222A	1
2	Variable power supply	0.3V, 2A	2
3	Voltmeter	0-10V	
4	Resistor	$R_C = 1K\Omega$, 0.25W $R_B = 2.2K\Omega$, 0.25W $R_C = 1K\Omega$, 0.25W	
5	Wires		Assorted.

Design:



Design steps:

1) When the transistor is in saturation the collector voltage will be

$$V_C = V_{csat} = 0.2V$$

2) The collector current is given by

$$I_{csat} = (V_{cc} - V_{csat})/R_C$$

$$= \frac{5 - 0.2}{1K} = 4.8mA$$

3) To saturate the BJT with the lowest β, we need to provide a base current of atleast

$$I_{BEOS} = I_{C(EOS)}/\beta = \frac{4.8mA}{30} = 0.16mA.$$

4) For an overdrive factor of 10, the current should be alteast

$$I_B = 10 \times I_{BEOS} = 1.6mA$$

5) Required R_B is

$$R_B = (V_B - V_{BE})/I_B = \frac{5 - 0.7}{1.6} = 2.6K\Omega$$

KLE TECHNOLOGICAL UNIVERSITY, Bhoomaraddi Campus, Hubballi

EXPERIMENT NO. :

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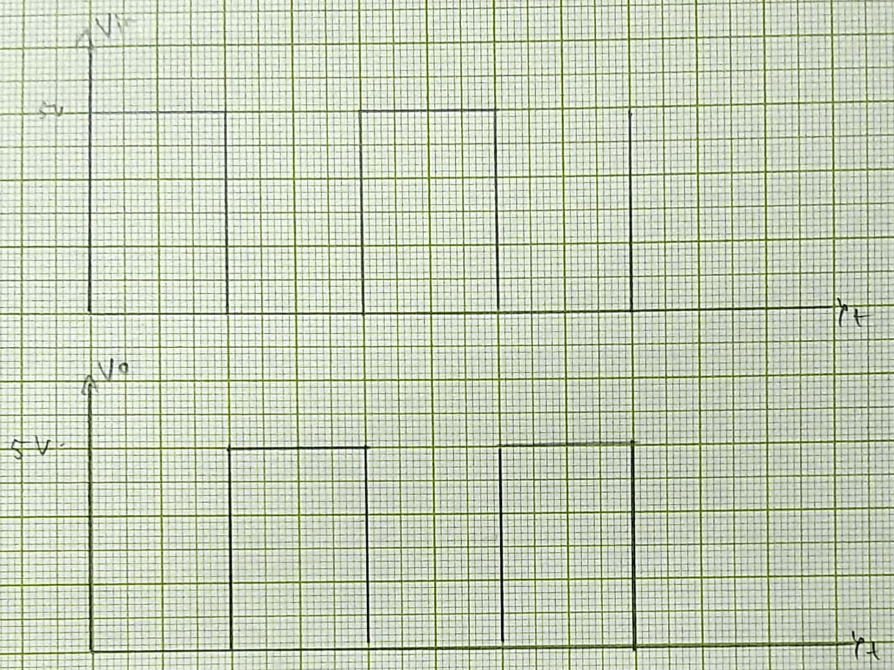


Procedure :

i) Connect the circuit as shown.

ii) Apply a 5V, 1KHz pulse signal with 50% duty cycle as input.

iii) Observe the output at collector terminal voltage.

OR

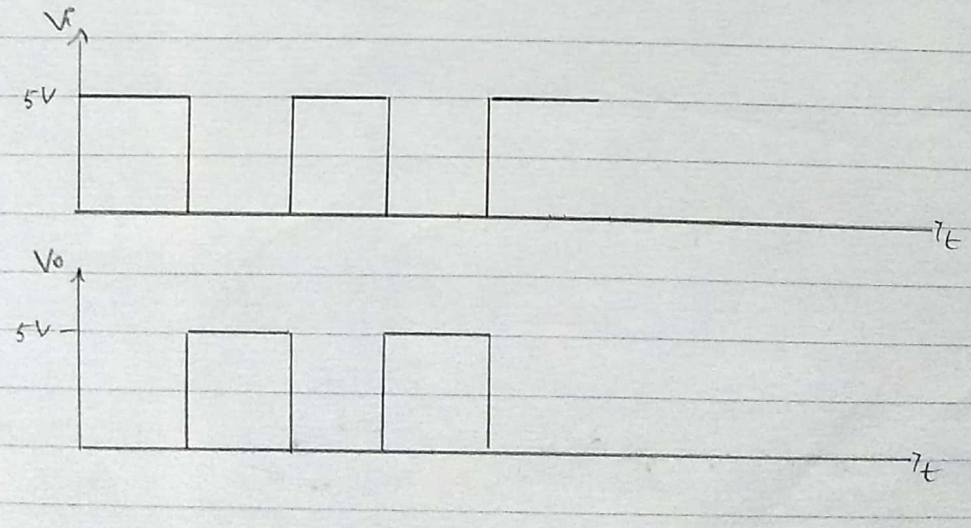
1) Set V_B to 0V and note the corresponding output voltage across collector and emitter terminal.

2) And similarly set V_B to 5V and note the output voltage across collector and emitter terminal.

Table of observation.

Vin in Volts	Vo in volts	BJT condition.
0V	5V	Cut-off
5V	0V	Saturation.

Nature of Graph:



Result and Discussion :

Experimental setup for BJT as switch in CE configuration is done and tested for different input signals conditions to identify different regions of operation.

∴ Cut off and saturation region.

To summarise BJT as a switch, input and output voltage observed are

- with $V_{BB} = 0V$, transistor is in cut-off region & hence output voltage $V_0 = V_{CE}$.
- with $V_{BB} = 5V$, $V_{BE} = 0.6V$ transistor is operated in saturation region and hence output voltage $V_0 = V_{CE\,sat} = 0.2V$.

Conclusion :

BJT a three terminal device working as voltage controlled current source can be used as a switch operating in two condition ie ON & Off. Finding major applications in realizing digital gates.