NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE

(Accredited by NAAC, Approved by AICTE New Delhi, Affiliated to APJKTU)

Pampady, Thiruvilwamala(PO), Thrissur(DT), Kerala 680 588

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

LAB WORK BOOK

ECL 202:ANALOG ELECTRONICS AND SIMULATION LABORATORY

VISION OF THE INSTITUTION

To mould our youngsters into Millennium Leaders not only in Technological and Scientific Fields but also to nurture and strengthen the innate goodness and human nature in them, to equip them to face the future challenges in technological break troughs and information explosions and deliver the bounties of frontier knowledge for the benefit of humankind in general and the down-trodden and underprivileged in particular as envisaged by our great Prime Minister Panduit Jawaharlal Nehru

MISSION OF THE INSTITUTION

To build a strong Centre of Excellence in Learning and Research in Engineering and Frontier Technology, to facilitate students to learn and imbibe discipline, culture and spirituality, besides encouraging them to assimilate the latest technological knowhow and to render a helping hand to the under privileged, thereby acquiring happiness and imparting the same to others without any reservation whatsoever and to facilitate the College to emerge into a magnificent and mighty launching pad to turn out technological giants, dedicated research scientists and intellectual leaders of the society who could prepare the country for a quantum jump in all fields of Science and Technology

ABOUT DEPARTMENT

- Established in: 2002
- Course offered: B.Tech Electronics & Communication Engineering

  :M.techVLSI
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISSION

Providing Universal Communicative Electronics Engineers with corporate and social relevance towards sustainable developments through quality education.

DEPARTMENT MISSION

1) Imparting Quality education by providing excellent teaching, learning environment.

2) Transforming and adopting students in this knowledgeable era, where the electronic gadgets(things) are getting obsolete in short span.

3) To initiate multi-disciplinary activities to students at earliest and apply in their respective fieldsof interest later.

4) Promoting leading edge Research & Development through collaboration with academia &industry.

PROGRAMME EDUCATIONAL OBJECTIVES

I. Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

II. Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in life long learning in their profession.

III. Graduates shall have the ability to lead and contribute in a team entrusted with professional social and ethical responsibilities.

IV. Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

COURSE OUTCOME

CO 1	To acquire the basic knowledge about CRO by the measurement of current, voltage, frequency and phase shift.
CO 2	Experimentally test the working of diode clipping and clamping circuits.
CO 3	Develop working knowledge on rectifier circuits and its characteristics.
CO 4	To acquire the basic knowledge about RC coupled amplifier by measuring gain, impedance & frequency response.
CO 5	Develop working knowledge on FET amplifiers by measuring gain & impedance.
CO 6	Design and simulate the functioning of basic analog circuits using simulation tools.
CO 7	Design and demonstrate the functioning of basic analog circuits using discrete components.
CO 8	Function effectively as an individual and in a team to accomplish the given task.

CO VS PO'S AND PSO'S MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS013	PSO14
CO 1	3	2	1	2	3				2			2	2	2
CO 2	3	2	1	2	3				2			2	2	2
CO 3	3	2	2	2	3				2				2	2
CO 4	3	2	2	2	3				2				2	2
CO 5	3	2	2	2	3				2			2	2	2
CO 6	3	2	2	2	3				2			2	2	2
CO 7	3	2	1	2	3				2			2	2	2
CO 8	3	2	1	2	3				2			2	2	2

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

PREPARATION FOR THE LABORATORY SESSION
GENERAL INSTRUCTIONS TO STUDENTS

1. Read carefully and understand the description of the experiment in the lab manual. You may go to the lab at an earlier date to look at the experimental facility and understand it better. Consult the appropriate references to be completely familiar with the concepts and hardware.

2. Make sure that your observation for previous week experiment is evaluated by the faculty member and your have transferred all the contents to your record before entering to the lab/workshop.

3. At the beginning of the class, if the faculty or the instructor finds that a student is not adequately prepared, they will be marked as absent and not be allowed to perform the experiment.

4. Bring necessary material needed (writing materials, graphs, calculators, etc.) to perform the required preliminary analysis. It is a good idea to do sample calculations and as much of the analysis as possible during the session. Faculty help will be available. Errors in the procedure may thus be easily detected and rectified.

5. Please actively participate in class and don’t hesitate to ask questions. Please utilize the teaching assistants fully. To encourage you to be prepared and to read the lab manual before coming to the laboratory, unannounced questions may be asked at any time during the lab.

6. Carelessness in personal conduct or in handling equipment may result in serious injury to the individual or the equipment. Do not run near moving machinery/equipment’s. Always be on the alert for strange sounds. Guard against entangling clothes in moving parts of machinery.

7. Students must follow the proper dress code inside the laboratory. To protect clothing from dirt, wear a lab coat. Long hair should be tied back. Shoes covering the whole foot will have to be worn.

8. In performing the experiments, please proceed carefully to minimize any water spills, especially on the electric circuits and wire.

9. Maintain silence, order and discipline inside the lab. Don’t use cell phones inside the laboratory.

10. Any injury no matter how small must be reported to the instructor immediately.

11. Check with faculty members one week before the experiment to make sure that you have the handout for that experiment and all the apparatus.

AFTER THE LABORATORY SESSION

1. Clean up your work area.

2. Check with the technician before you leave.

3. Make sure you understand what kind of report is to be prepared and due submission of record is next lab class.

4. Do sample calculations and some preliminary work to verify that the experiment was successful

MAKE-UPS AND LATE WORK

Students must participate in all laboratory exercises as scheduled. They must obtain permissionfrom the faculty member for absence, which would be granted only under justifiablecircumstances. In such an event, a student must make arrangements for a make-up laboratory, which will be scheduled when the time is available after completing one cycle. Late submission will be awarded less mark for record and internals and zero in worst cases.

LABORATORY POLICIES

1. Food, beverages & mobile phones are not allowed in the laboratory at any time.

2. Do not sit or place anything on instrument benches.

3. Organizing laboratory experiments requires the help of laboratory technicians and staff. Be punctual.

SYLLABUS

Part A : List of Experiments using discrete components [Any Six experiments mandatory]

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier -frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators –RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

PART B: Simulation experiments [Any Six experiments mandatory]

The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE.

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier – frequency response

7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators – RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

FINAL VERIFICATION BY THE FACULTY
TOTAL MARKS:

INTERNAL EXAMINER **EXTERNAL EXAMINER**

EXPERIMENT NO : 1

STUDY & USE OF CRO

CRO

The Cathode Ray Oscilloscope is probably the most versatile tool for deployment of electronic circuit and system. The CRO allow the amplitude of the electronic signals where they are voltage, current or power to be displayed as a function of time. The CRO depends on the moments of an electron beam which is being bombarded (impinged) on a screen coated with a fluorescent material to produce a visual spot. If the electron is being deflected along the conventional axes, i.e. x-axis & y-axis, two different displays are produced.

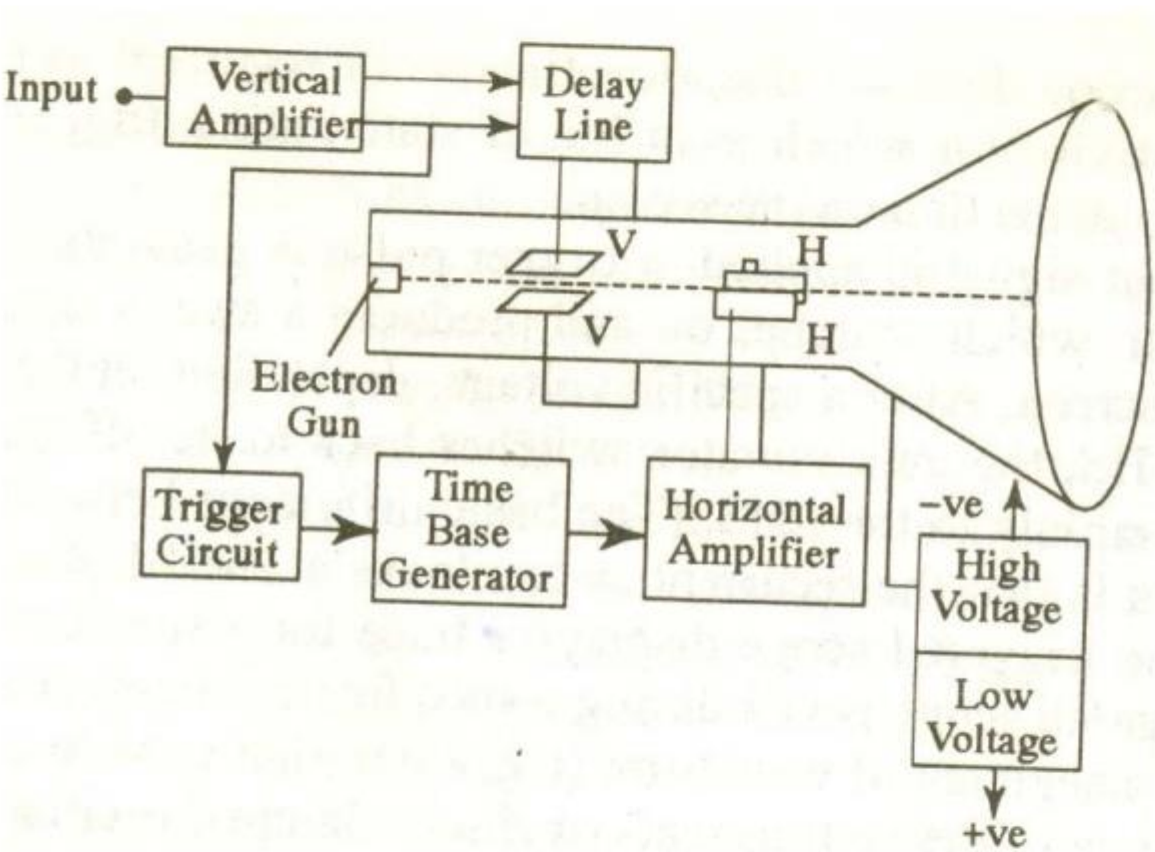


Fig:1 Block Diagram of CRO

Main parts of CRO-

CRT: - This is cathode ray tube in which electron beam strikes the screen internally to provide visual display of signal.

VERTICAL AMPLIFIER:- This is a wide band amplifier used to amplify signal in the vertical section of the signal.
DELAY LINE: – It is used to delay signal for sometime in the vertical section.
TIME BASE: – It is used to generate sawtooth voltage which it is applied to Horizontal deflection plates.
HORIZONTAL AMPLIFIER: - This is used to amplify the sawtooth voltage before it is applied to horizontal deflection plates.
TRIGGER CIRCUIT: - This is used to convert the incoming signal into trigger pulse so that the input signal and the sweep frequency can be synchronized.
POWER SUPPLY: – There are two power supplies, A negative high voltage (HV). supply and a +ve low voltage supply (LV). . The +ve voltage supply is from +300V to 400V, the negative voltage supply is from -1000V to -1500V.

Front panel controls

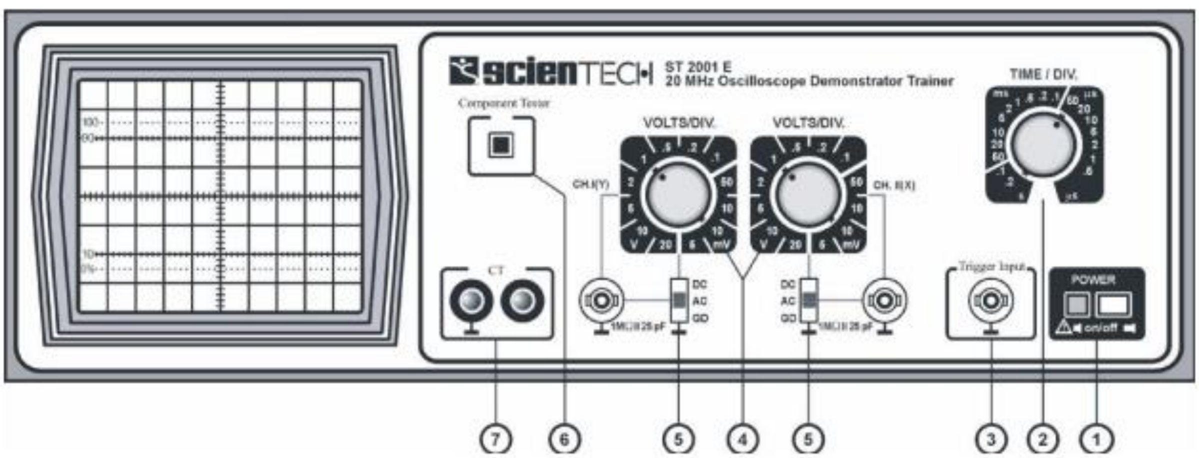


Fig:2 Front Panel of CRO

(1) Power 'On/Off' : Turns 'On' & 'Off'. LED indicates power 'On'. Use position & Int/Focus controls to get the beam. All are push buttons.
(2) Time / Div : Rotary Switch for TB speed control.
(3) Trigger Input : For feeding external trigger signal.
(4) Volts/Div : For sensitivity selection of CH 1 & CH 2.
(5) DC-AC-Gnd : Switch provided for Input coupling. BNC inputs provided for connecting the Input signal.
(6) Component Tester : Switch when pressed converts scope into Component Tester mode.
(7) CT : Input & Gnd terminals to be used for CT.

Controls on PCB

(1) Intensity : Controls the brightness
(2) Focus : Controls the sharpness
(3) Trace Rotation : Controls the horizontal alignment of the trace.
(4) X Pos : Controls the horizontal position
(5) Y Pos I & II : Controls vertical position of the trace.

(6) X Y : When pressed cuts-off internal TB & connects external horizontal signal via. CH II
(7) X 5 : When pressed gives 5 times magnification.
(8) External : When pressed allows ext. trigger.

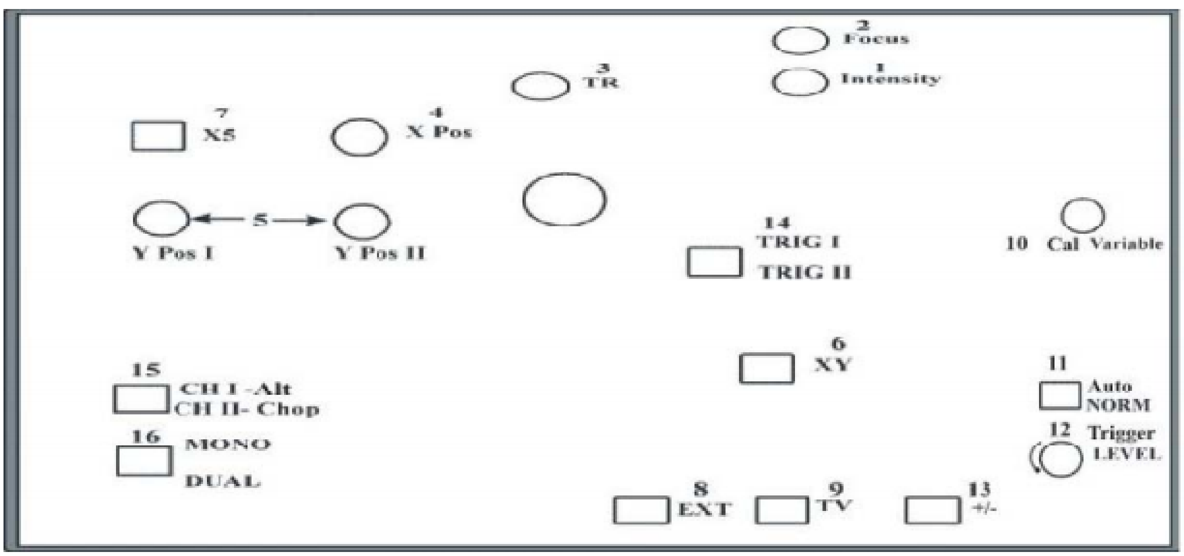


Fig:3 Controls on PCB

(9) TV : When pressed allows TV frame to be synchronized.
(10) Cal Variable : Controls the time speed in between the steps.
(11) Auto/ Norm : In AT gives display of trace & auto trigger.When pressed becomes normal & gives variable level trigger.
(12) Level : Controls the trigger level from positive peak to negative peak.
(13) + / - : Selects the slope of triggering.
(14) Trig 1/ Trig 2 : When out triggers CH I and when pressed triggers CH II
(15) CH I Alt/ : When out selects CH I and when pressed selects CH II. When dual switch also pressed this selects Alt or Chop modes.
(16) Mono / Dual : When out, selects CH I only. When pressed selects both.

Amplitude Measurements :

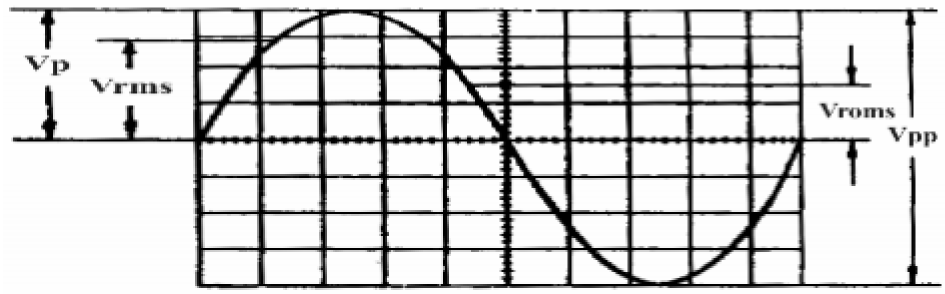


Fig:4 Amplitude measurement using CRO

Vrms = effective value
Vp = simple peak or crest value
Vpp = peak-to-peak value
Vmom = momentary value.

Frequency measurement

T = time in seconds for one period
F = recurrence frequency in Hz of the signals,
F = 1/T,

T_{tot} = 1.6 cm x 0.5 s/cm : 5 = 160ns

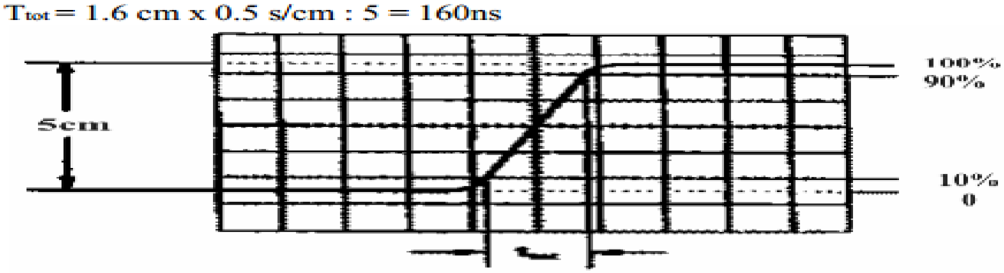


Fig:5 Frequency measurement using CRO

RESULT

Experiment No: 2

RC DIFFERENTIATOR & INTEGRATOR CIRCUIT

Aim:

1. To design and setup an RC integrator and differentiator circuits and plot its output waveforms
2. To plot the frequency response of low pass filter & high pass filter.

Components required:

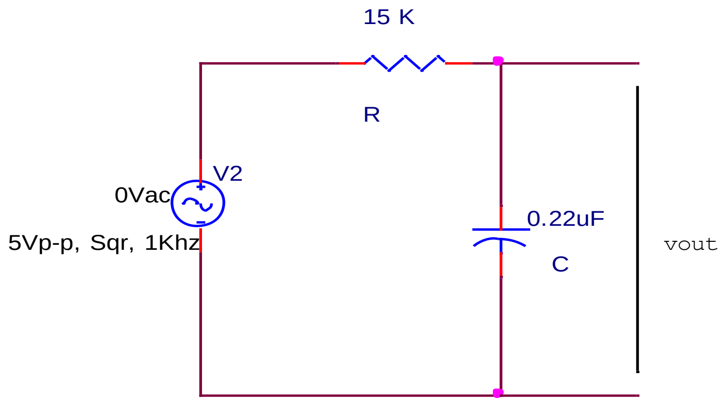
Power Supply

Resistor

Capacitor

Procedure:

1. Set up the circuit as shown in the figure
2. Apply the square wave of 5V pp at 1 KHz.
3. Observe the output and plot it.
4. Keeping the input amplitude constant and vary the frequency from 20Hz to 1MHz.
5. Measure the output amplitude for each frequency for both differentiator & integrator circuits..
6. Plot the frequency response curve with gain in dB along Y-axis and log of frequency in X-axis.
7. <u>**CIRCUIT DIAGRAM**</u>
8. **RC integrator:**

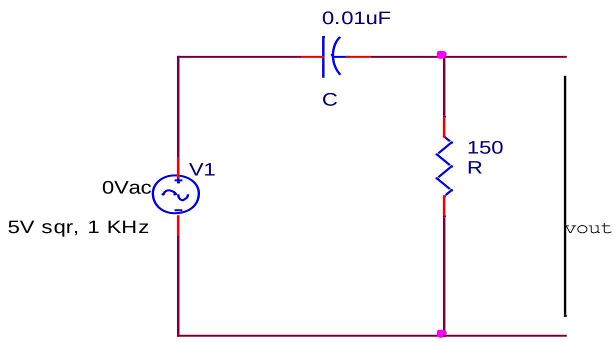


Let the frequency of input be 1 KHz, T = 1 ms

For RC integrator, RC ≥ 16T;

Let, C = 1μF, R = 15 KΩ

RC Differentiator:



Let frequency of input be 1 KHz; T = 1 ms;

For differentiator, RC ≤ 0.0016 T;

Choose C = 0.01μF, R = 150Ω

RESULT

EXPERIMENT NO : 3

DIODE CLIPPING CIRCUITS

Aim: To design and test diode clipping circuits for peak clipping and peak detection.

Components required:

-Power Supply

-Diodes IN4007or BY127

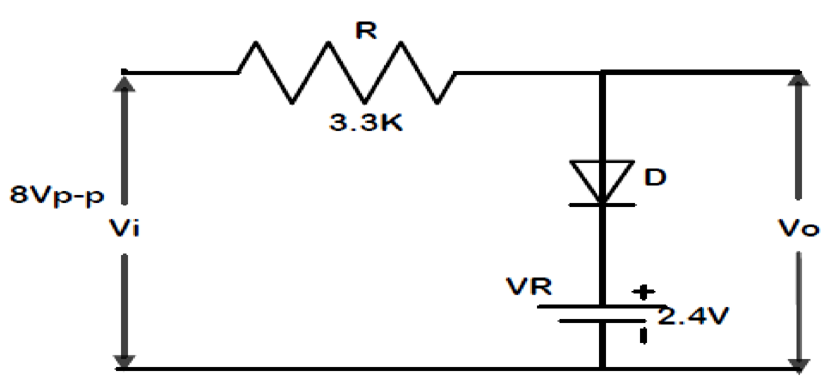
-Resistors

Procedure:

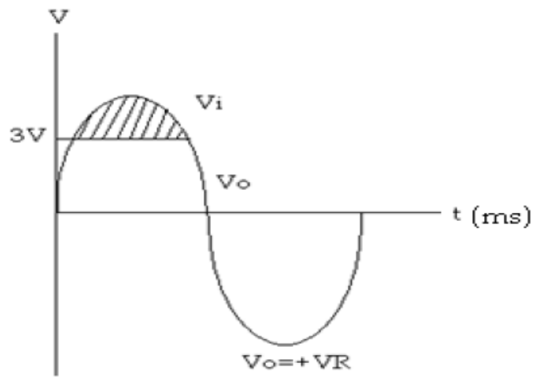
- Make the Connections as shown in the circuit diagram
- Apply sinusoidal input Vi of 1 KHz and of amplitude 8V P-P to the circuit.
- Observe the output signal in the CRO and verify it with given waveforms.
- Apply Vi and Vo to the X and Y channel of CRO and observe the transfer characteristic waveform and verify it.

I) **Positive Clipping Circuit:**

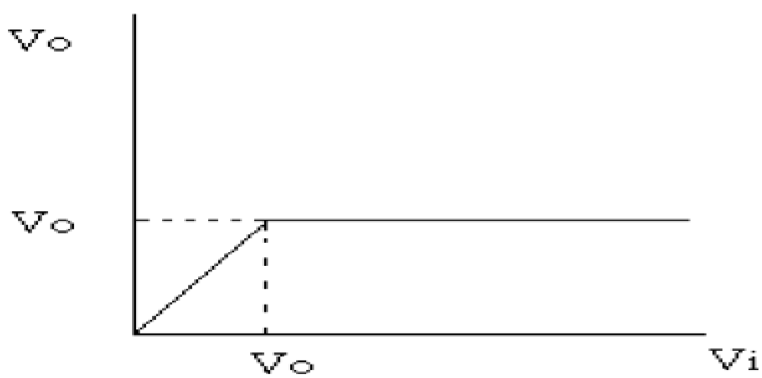
Circuit Diagram:



Waveforms:



Transfer Characteristics:



To find the value of R:

Given: Rf =100Ω, Rr =100KΩ

Rf - Diode forward resistance

Rr - Diode reverse resistance

$$R = \sqrt{R_f R_r} = \sqrt{100 \times 100 \times 10^3} = 3.16K\Omega$$

Choose R as 10 KΩ

Let the output voltage be clipped at +3V

Vomax =3V

From the circuit diagram,

Vomax = Vr+Vref

Where Vr is the diode drop = 0.6V

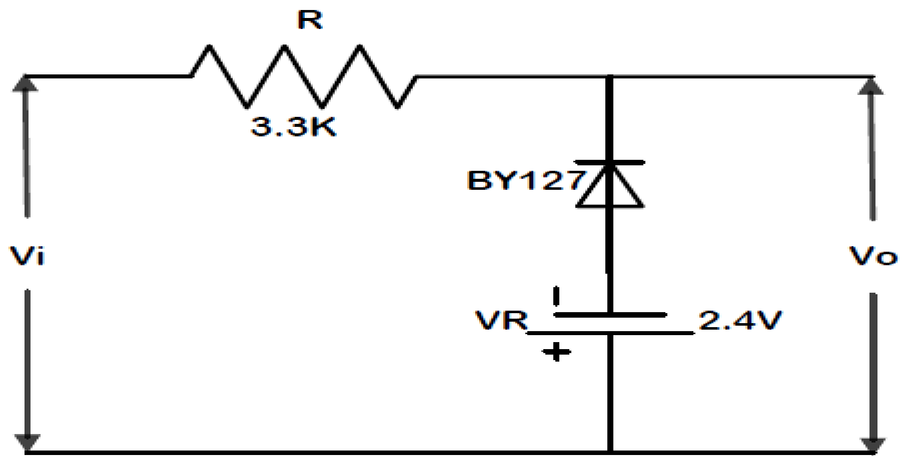
Vref = Vomax -Vr

=3 - 0.7

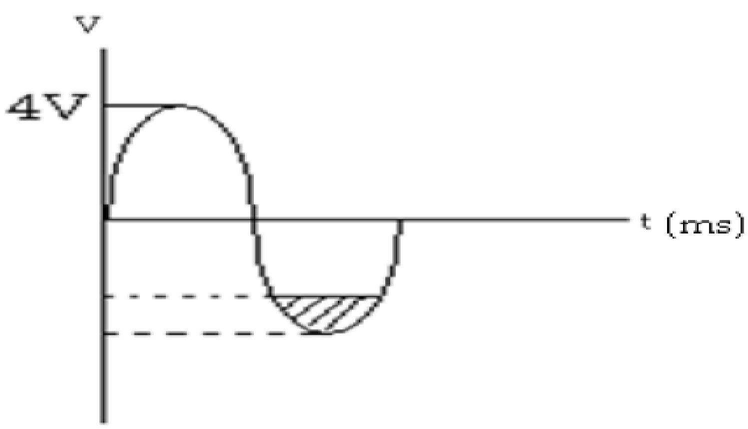
Vref = 2.3 V

II) **Negative Clipping Circuit:**

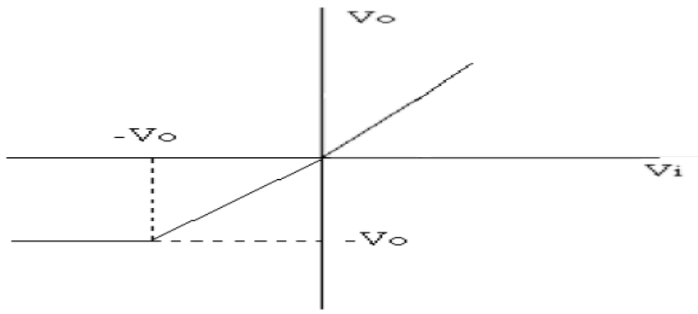
Circuit Diagram:



Waveforms:



Transfer Characteristics:



Let the output voltage be clipped at -3V

Vomin = -3V

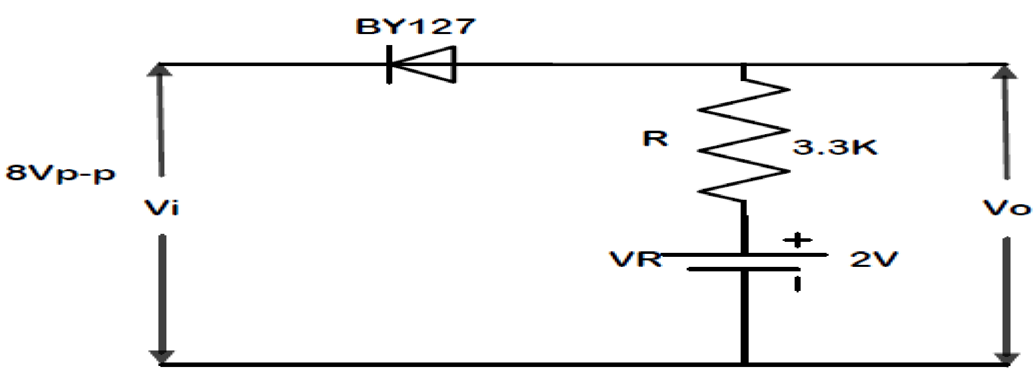
Vomin = -Vr+Vref

Vref = Vomin+Vr = -3 + 0.7

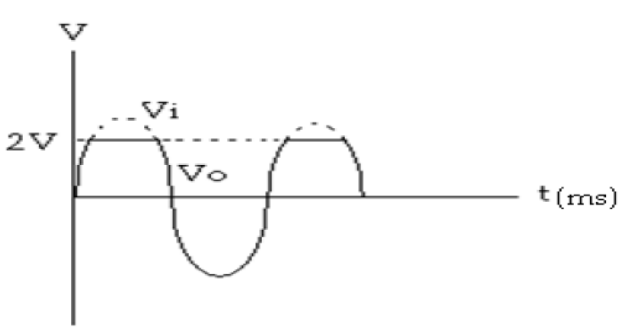
Vref = -2.3V

III) **Diode Series Clipping / Positive Peak Clipper:**

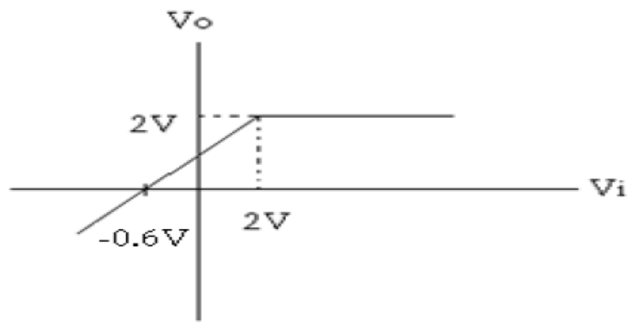
Circuit Diagram:



Waveforms:



Transfer Characteristics:

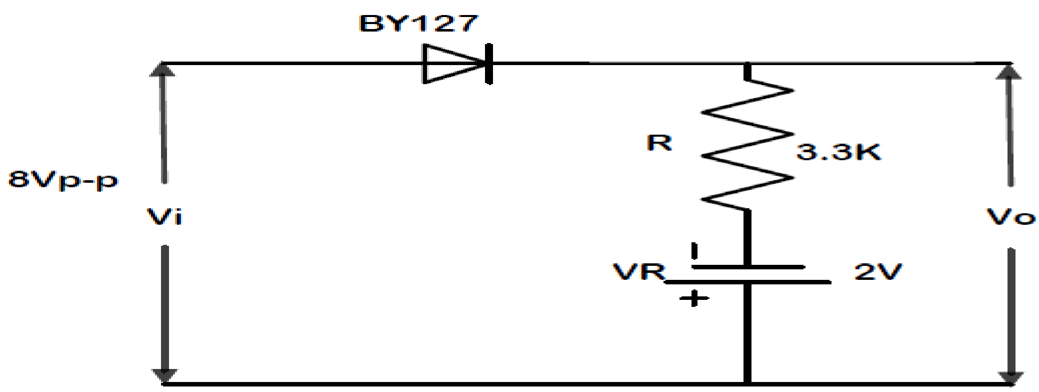


Let the output voltage be clipped at 2V

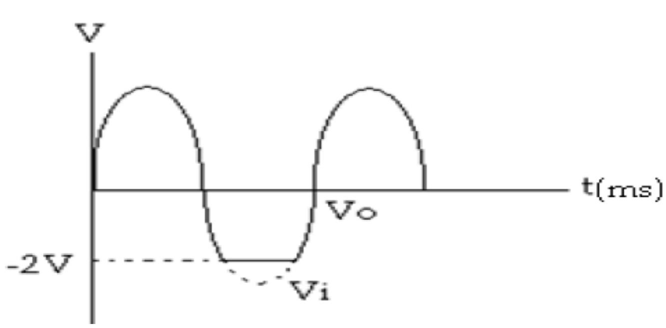
Vomax = Vref = 2V

IV) **Negative Peak Clipper:**

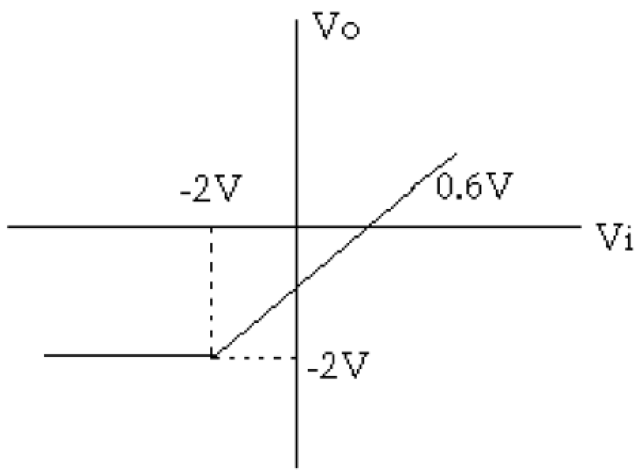
Circuit Diagram:



Waveforms:



Transfer Characteristics:

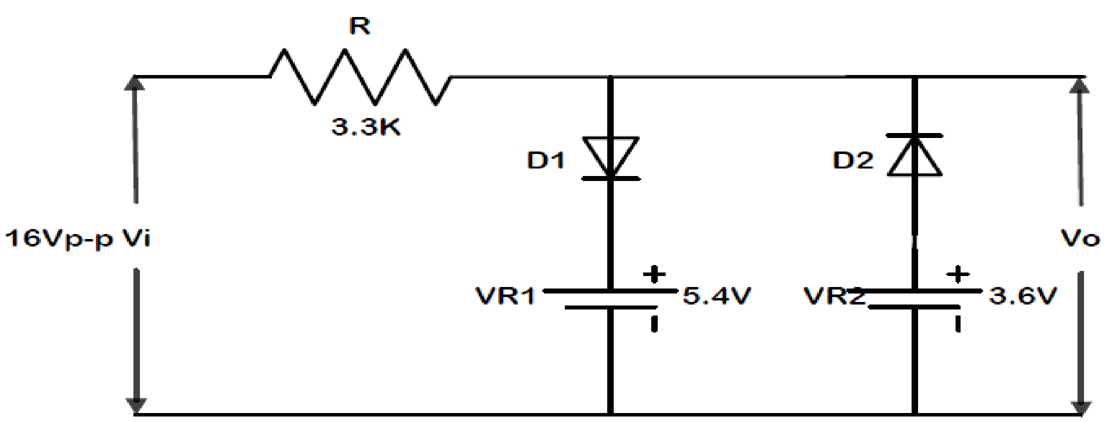


Let the output voltage be clipped at -2V

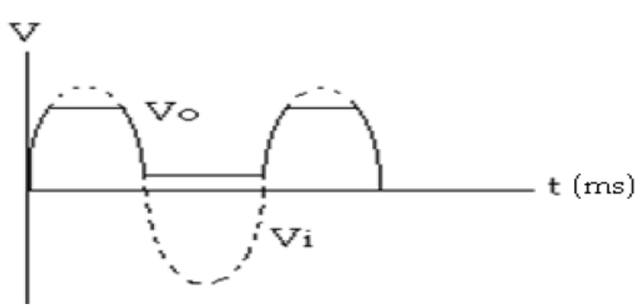
Vomin = Vref = -2V

V) **Clipping at two independent levels:**

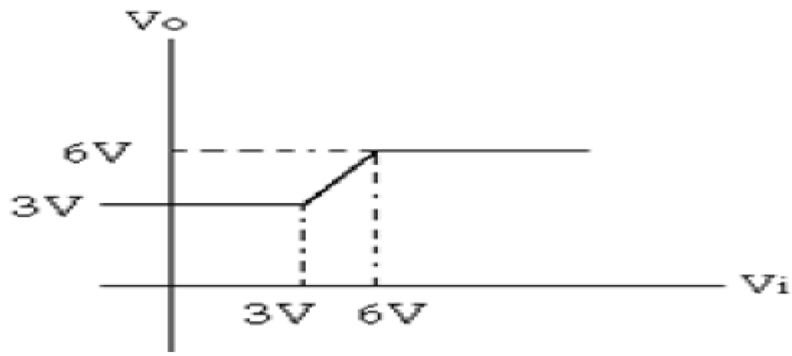
Circuit Diagram:



Waveforms:



Transfer Characteristics:



Let Vomax = 6V and Vomin = 3V

Vomax = Vr1 + Vr

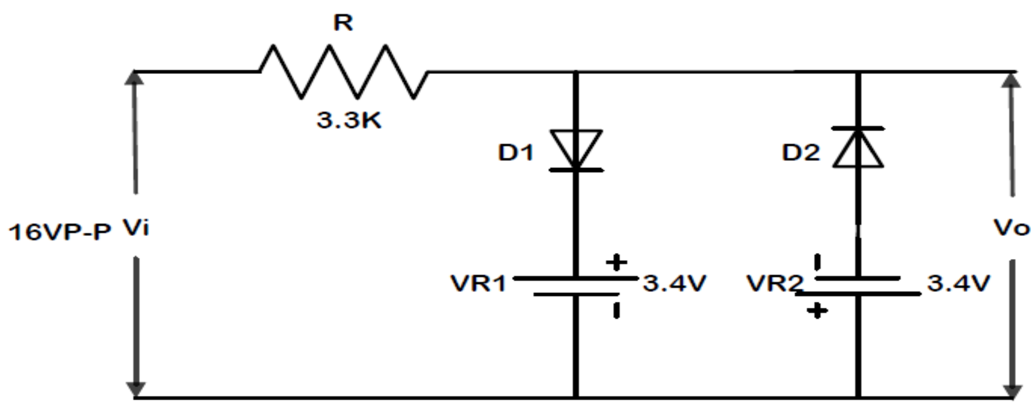
Vr1 = Vomax - Vr = 6 – 0.7 = 5.3V

Vomin = Vr2- Vr

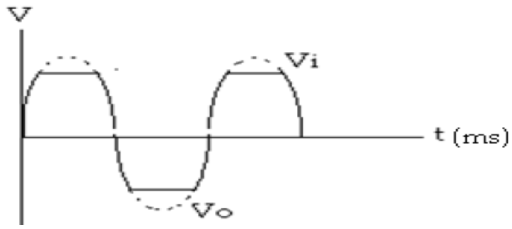
Vr2 = Vomin + Vr = 3 + 0.7= 3.7V

VI) **Double ended clipper to generate a symmetric square wave:**

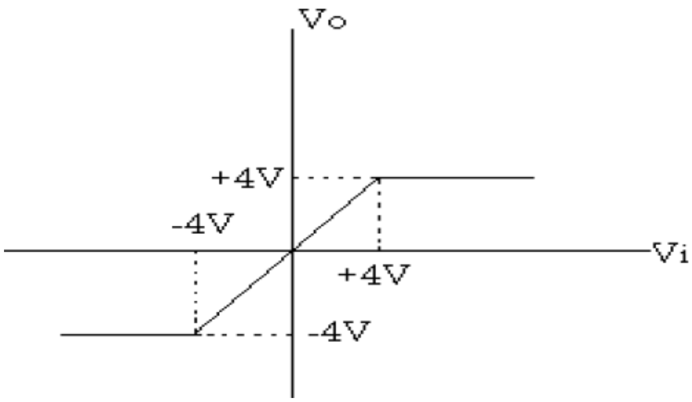
Circuit Diagram:



Waveforms:



Transfer Characteristics:



Let VR1 = VR2 = VR, Vomax = 4V

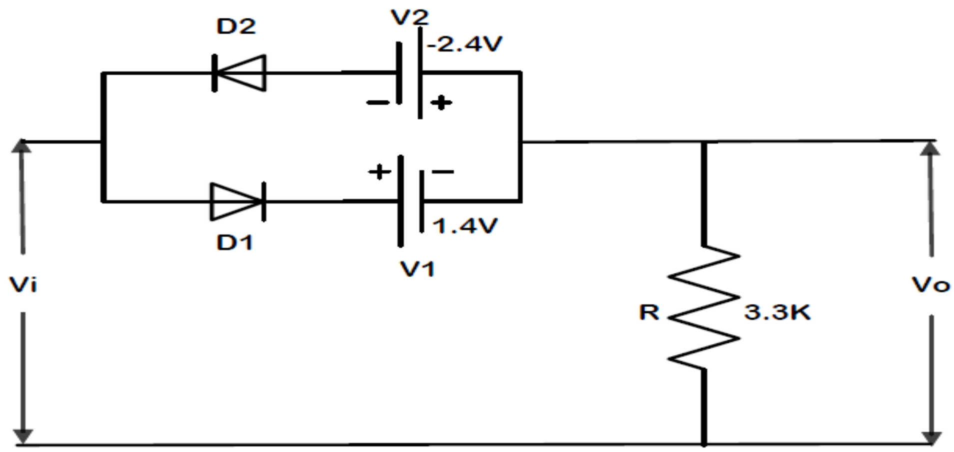
Vomax = VR + Vr

VR = Vomax – Vr = 4 – 0.7

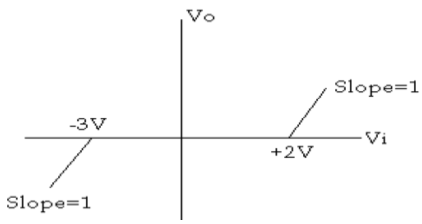
VR = 3.3V

VII) **To Clip a sine wave between +2V and -3V level:**

Circuit Diagram:



Transfer Characteristics:



To Clip a sine wave between +2V and -3V level

Vo = V1 + Vr

V1 = Vo - Vr = 2-0.7

V1 = 1.4V

Vo = V2 - Vr

-3 = V2 – 0.7

V2 = -3 + 0.7

V2 = -2.3V

RESULT

EXPERIMENT NO : 4

CLAMPING CIRCUITS

Aim: Design and test positive and negative clamping circuit for a given reference voltage.

Components required:

- Power Supply
- CRO
- Signal Generator
- Diode BY 127
- Resistors
- Capacitor

Design:

Rf – Diode forward resistance = 100Ω

Rr – Diode Reverse resistance = 1M Ω

$$\mathrm{R} = \sqrt{R_f R_r} = 10\mathrm{K}\Omega$$

$$RC \gg T$$

let T = 1ms f(1KHz)

Let RC = 10T

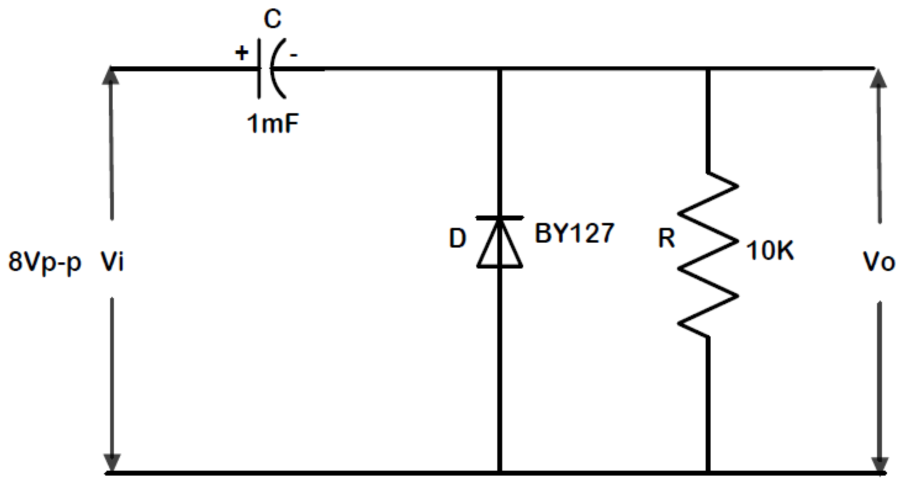
RC = 10ms

C = 1μF

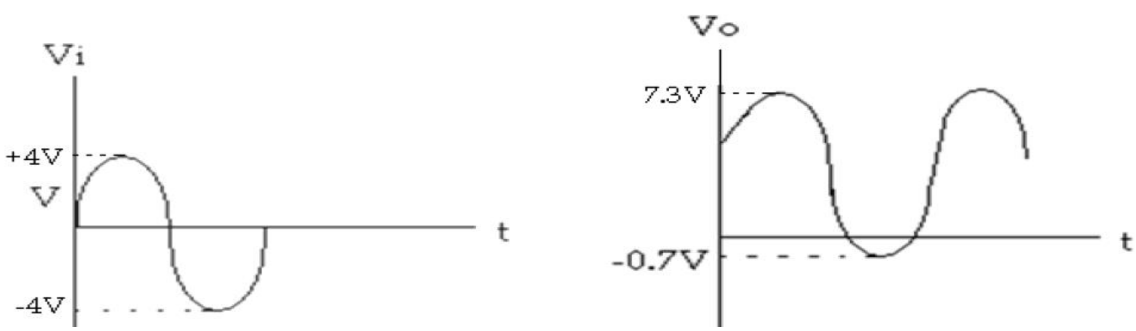
R = 10KΩ

I) **Positive Clamping Circuits:**

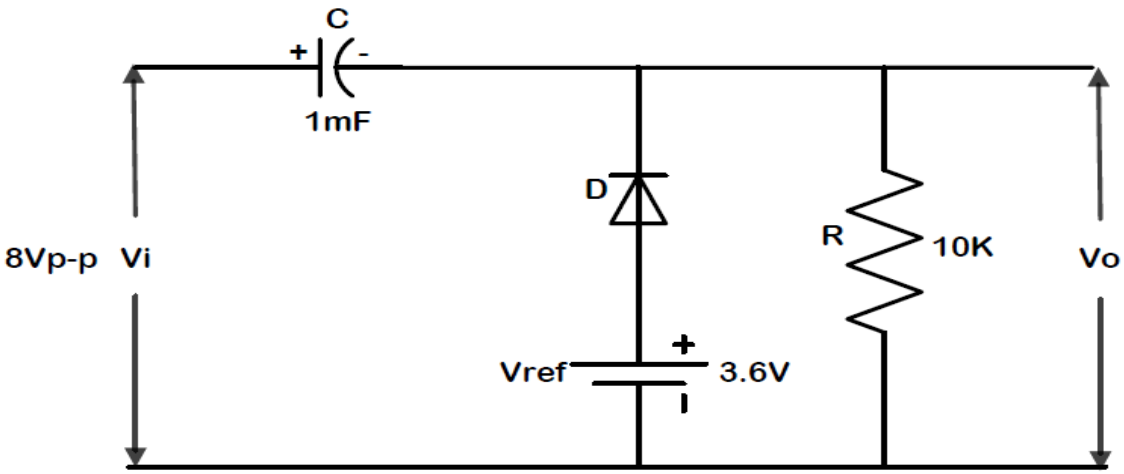
Circuit Diagram:



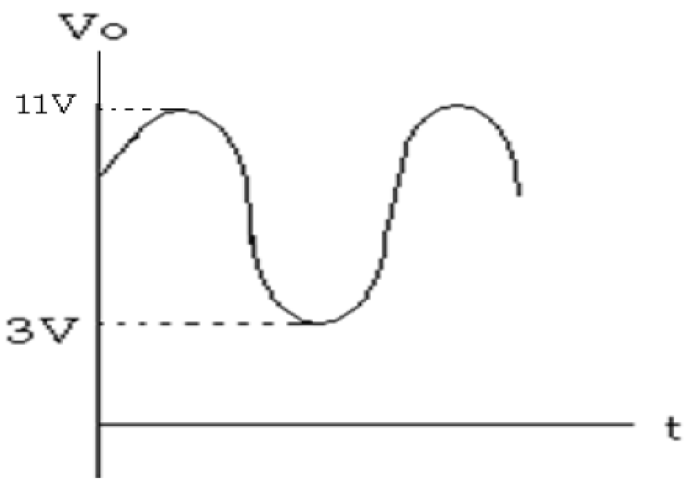
Waveforms:



II) **Design a Clamping Circuit to Clamp Negative Peak at +3V:**



Waveforms:



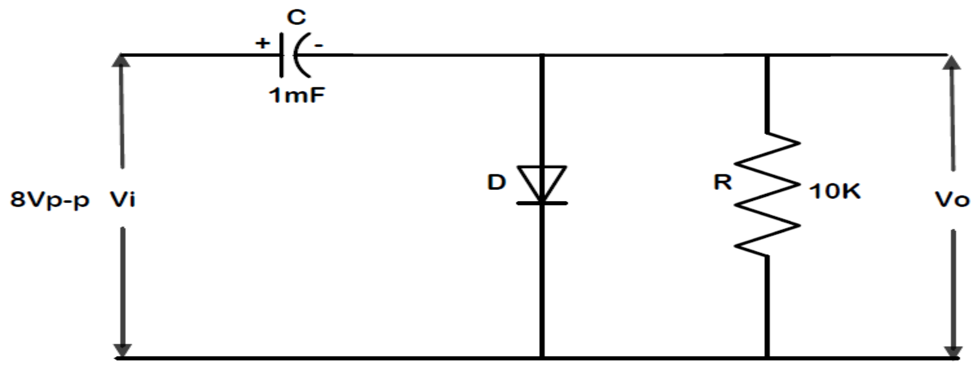
$$V_o = V_{\vartheta} + V_{ref}$$

3 = -0.7 + Vref,

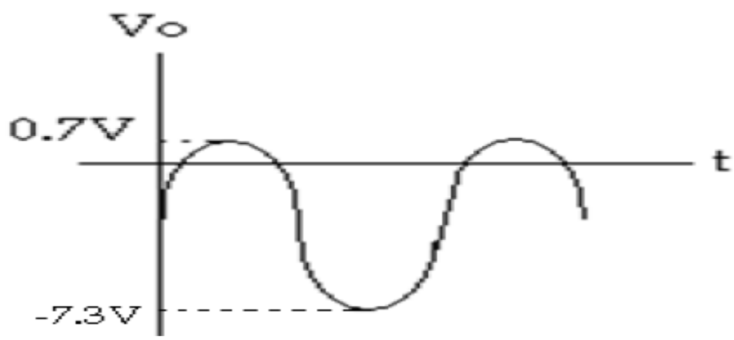
Vref = 3.7

III) **Negative Clamping Circuit:**

Circuit Diagram:

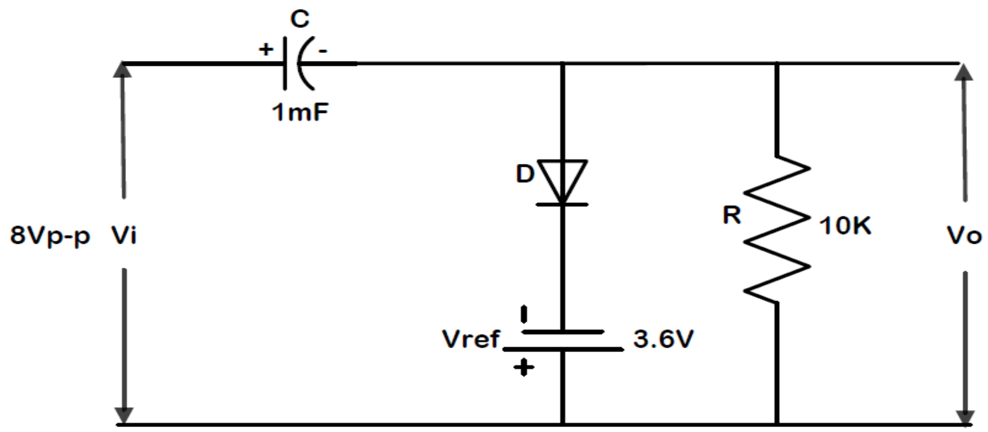


Waveforms:

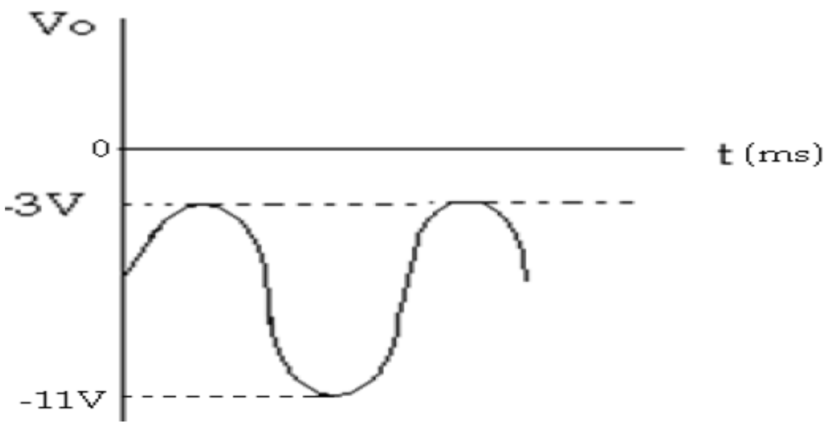


IV) **Design a Clamping Circuit to clamp Positive Peak at -3V:**

Circuit Diagram:



Waveforms:



$$V_o = V_\vartheta - V_{ref}$$

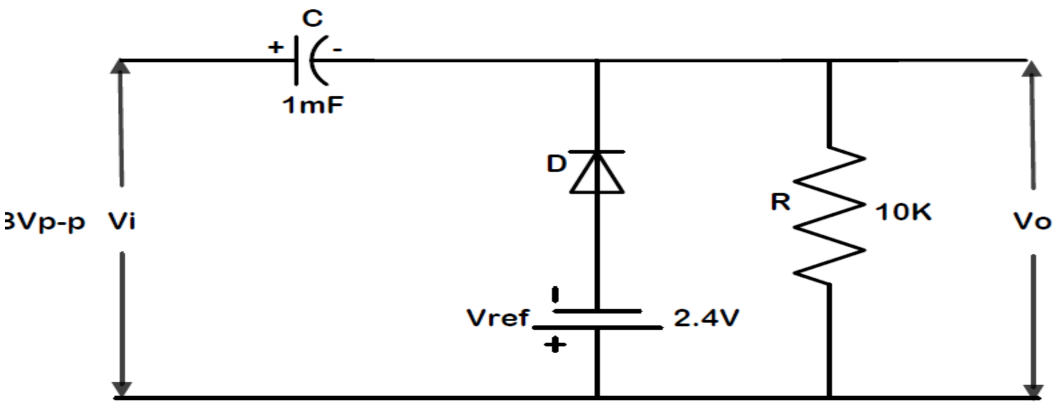
$$V_{ref} = | - V_o + V_\vartheta$$

= +3+0.7

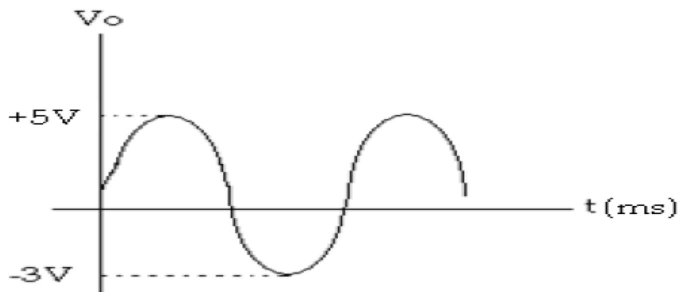
Vref = 3.7

V) **Design a Clamping Circuit to Clamp Negative Peak at -3V:**

Circuit Diagram:



Waveforms:



$$V_o = -(V_\vartheta + V_{ref})$$

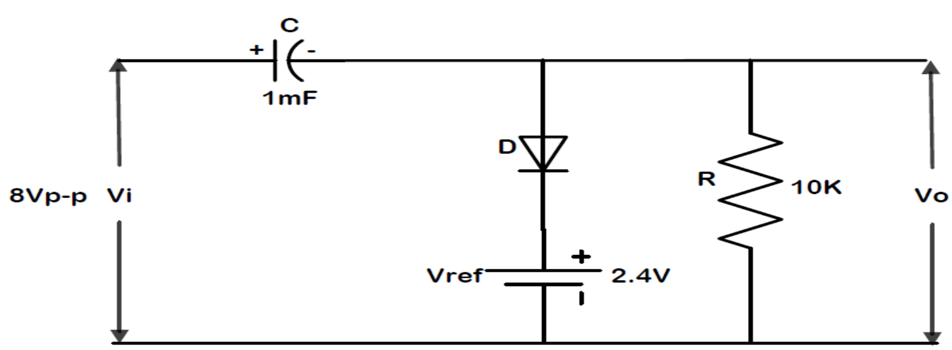
$$V_{ref} = -V_o - V_\vartheta$$

= - 0.7 – (- 3)

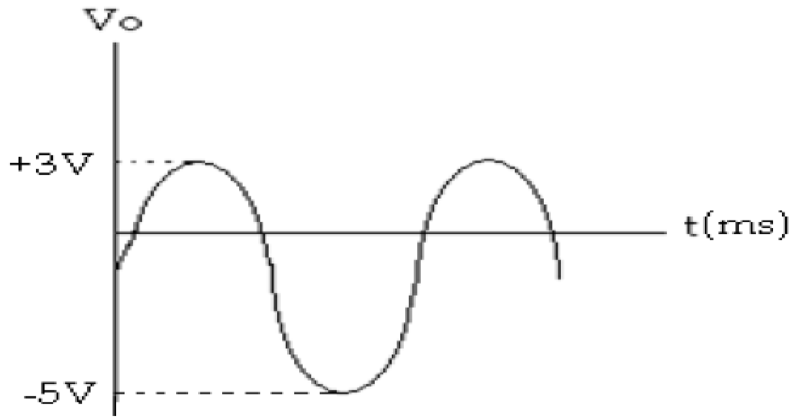
Vref =+2.3V

VI) **Design a Clamping Circuit to clamp Positive Peak at +3V:**

Circuit Diagram:



Waveforms:



$$V_o = V_\vartheta + V_{ref}$$

$$V_{ref} = V_o - V_\vartheta$$

= 3 - 0.7

Vref = 2.7V

Procedure:

- Rig up the circuit.
- Apply sinusoidal input signal of 8V P-P from signal generator.
- Observe the output waveform in the CRO.
- Note down the readings from the CRO and compare it with the expected values.

RESULT

EXPERIMENT NO : 5

RC-COUPLED AMPLIFIER

Aim: To design and setup an RC Coupled amplifier using BJT & to find the input and output impedance of the RC-Coupled amplifier.

Components Required:

- Transistor
- Capacitor
- Resistors
- Signal Generator
- CRO

Design:

Let Vcc = 10V

Ic = 5mA

β = 100

To find RE:

$$V_{RE} = \frac{Vcc}{10} = \frac{10}{10} = 1V$$

i.e. $I_E R_E = 1V$

$$R_E = \frac{1V}{I_E} = \frac{1V}{I_C} = \frac{1V}{5mA} = 200\Omega$$

Select $R_E = 220\Omega$

To find R_C:

$$V_{CE} = \frac{V_{CC}}{2} = \frac{10}{2} = 5V$$

Apply KVL to CE loop,

$$V_{CC} - I_C R_C - V_{CE} - V_{BE} = 0$$

$$10 - 5mR_C - 5 - 1 = 0$$

$$R_C = 800\Omega$$

Select R_C as 820 Ω

To find R_1:

From the above biasing circuit,

$$V_B = V_{BE} + V_{RE} = 0.7 + 1 = 1.7V$$

$$I_C = \beta\, I_B \text{ or } I_B = \frac{I_C}{\beta} = \frac{5m}{100} = 0.05mA$$

Assume 10 I_B flows through R_1

$$\therefore R_1 = \frac{V_{CC} - V_B}{10\, I_B} = \frac{10 - 1.7}{10 \times 0.050}$$

$$R_1 = 16.6K\Omega$$

Select R_1 as 18KΩ

Assume 9 I_B flows through R2

$$\therefore R_2 = \frac{V_B}{9\, I_B} = \frac{1.7}{9 \times 0.050m} = 3.7K\Omega$$

Select R_2 as 3.9KΩ

Bypass capacitor C_E and coupling Capacitor C_{C1} and C_{C2}

Let $X_{CE} = \frac{1}{10} R_E$ at f = 100Hz

i.e. $\frac{1}{2\pi f C_E} = \frac{R_E}{10}$

$\therefore C_E = \frac{10}{2\pi \times 100 \times 220} = 72.3\mu F$

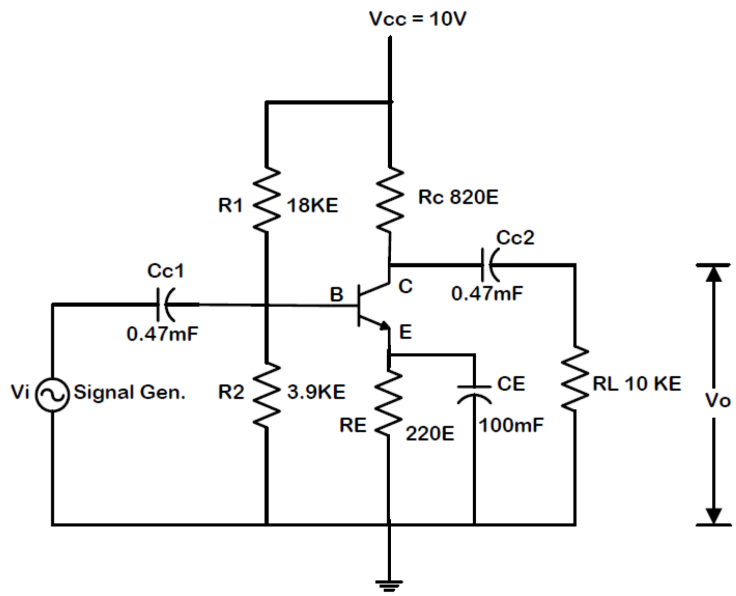
Select C_E as $100\mu F$

Also use $C_{C1} = C_{C2} = 0.47\ \mu F$

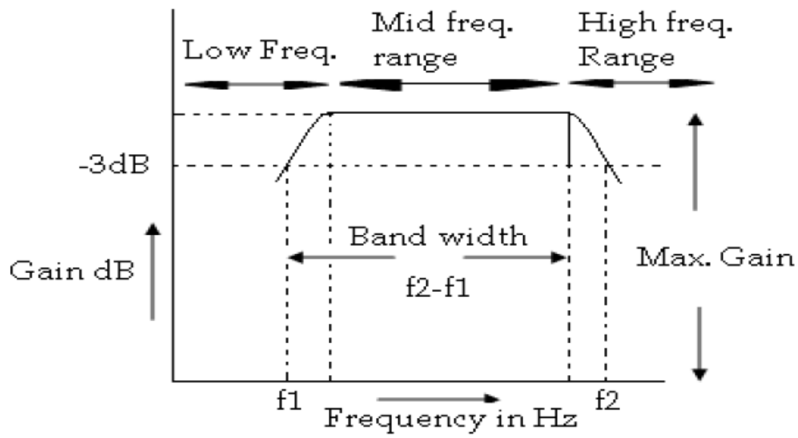
Procedure:

- Rig up the circuit
- Apply the sinusoidal input of 50m(P-P) and observe the input and output waveforms simultaneously on the CRO screen
- By varying the frequency of the input from Hz to maximum value and note down the output voltages
- Plot the frequency response (gain in dB vs log f) and determine the bandwidth from the graph

Circuit Diagram:



Waveforms:



Tabular Column:

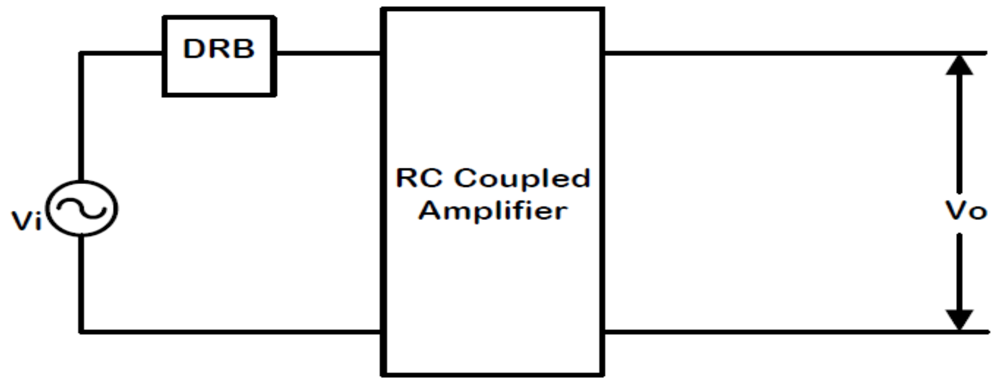
Freq. in Hz	$V_{o\ P\text{-}P}$	$A_V = V_o / V_1$	Gain in dB = $20 \log_{10} A_V$
50 Hz			
100 Hz			
200 Hz			
300 Hz			
500 Hz			
1KHz			

To measure input impedance and output impedance:

I) Input impedance (Ri):

Procedure:

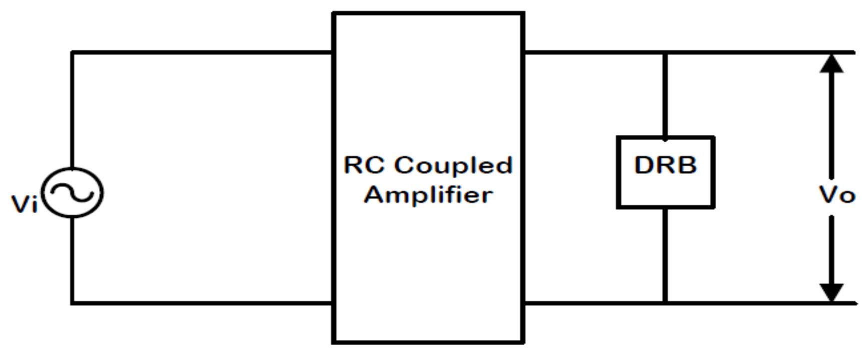
- Connect the circuit as shown
- Set the DRB to a minimum value
- Set the output to a convenient level and note down the output voltage
- Increase the DRB value till VO becomes half of the maximum amplitude
- The corresponding DRB value gives input impedance



II) Output impedance (RO):

Procedure:

- Connect the circuit as shown
- Set the DRB to a maximum value
- Set the output to a convenient level and note down the output voltage
- Increase the DRB value till VO becomes half of the maximum amplitude
- The corresponding DRB value gives input impedance



RESULT:

Bandwidth: __________Hz

Input Impedance: __________Ω

Output Impedance: __________Ω

EXPERIMENT NO : 6

VOLTAGE-SERTES FEEDBACK AMPLIFIER

AIM: To study the effect of voltage series feedback on Gain of the Amplifier.

APPARATUS:

Transistor BC 107

Breadboard

Regulated Power Supply(0-30V,1A)

Function Generator

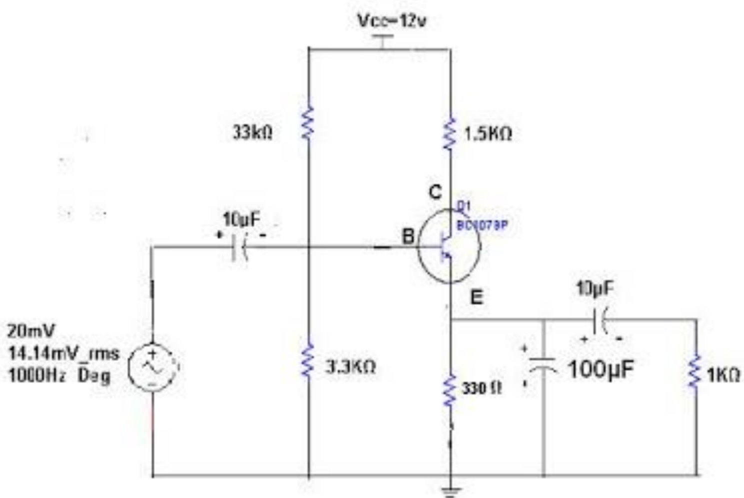
CRO(30 Mhz,dualtrace)

Resistors 33kΩ,3.3k Ω,1.5kΩ,1kΩ,2.2k Ω,4.7k Ω,330Ω

Capacitors 10µF - 2Nos

100µF - 1No

CIRCUIT DIAGRAM:



THEORY:

When any increase in the output signal results into the input in such a way as to cause the decrease in the output signal, the amplifier is said to have negative feedback.

The advantages of providing negative feedback are that the transfer gain of the amplifier with feedback can be stablised against varations in the hybrid parameteresof the transistor or the parameters of the other active devices used in the circuit. The most advantage of the negative feedback is that by propere use of this , there is significant improvement in the frequency respponse and in the linearity of the operation of the amplifier.This disadvantage of the negative feedback is that the voltage gain is decreased.

In Voltage-Series feedback , the input impedance of the amplifier is decreased and the output impedance is increased.Noise and distortionsare reduced cosiderably.

PROCEDURE:

1. Connections are made as per circuit diagram.
2. Keep the input voltage constant at 20mV peak-peak and 1kHz frequency.For different values of load resistance, note down the output voltage and calculate the gain by using the expression

   $A_v = 20\log(V_0 / V_i)$ dB
3. Add the emitter bypass capacitor and repeat STEP 2.And observe the effect of Feedback on the gain of the amplifier
4. For plotting the frquency the input voltage is kept constant at 20mV peak-peak and the frequency is varied from 100Hz to 1MHz.
5. Note down the value of output voltage for each frequency. All the readings are tabulated and the voltage gain in dB is calculated by using expression $A_v = 20\log(V_0 / V_i)$ dB
6. A graph is drawn by takung frquency on X-axis and gain on Y-axis on semi log graph sheet
7. The Bandwidth of the amplifier is calculated from the graph using the expression Bandwidth B.W = $f_2 – f_1$.

   Where f_1 is lower cutt off frequency of CE amplifier

   f_2 is upper cutt off frequency of CE amplifier

The gain-bandwidth product of the amplifier is calculated by using the expression

Gain-Bandwidth Product = 3-dB midband gain X Bandwidth.

OBSERVATIONS:

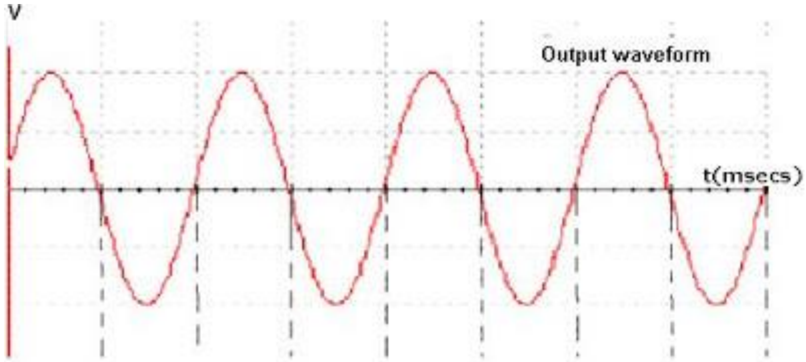
Voltage Gain:

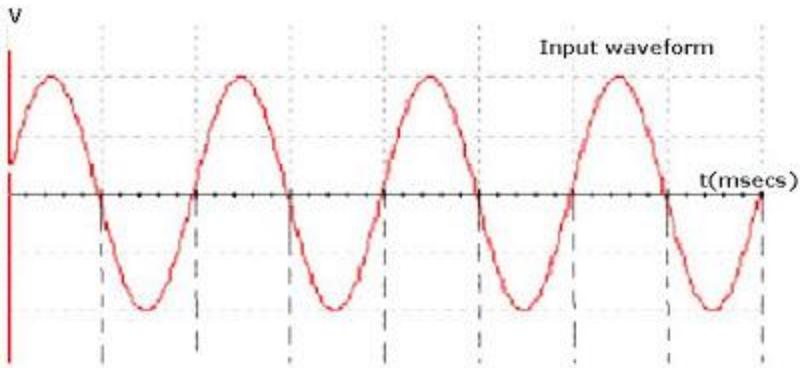
S.NO	Output Voltage (V_o) with feedback	Output Voltage (V_o) without feedback	Gain(dB) with feedback	Gain(dB) without feedback

Frequency Response: V_i = 20mV

S.NO	Frequency (Hz)	Output Voltage (V_o)	Gain A = V_o/V_i	Gain in dB 20log(V_o/V_i)

MODEL WAVEFORMS:





PRECAUTIONS :

1. While taking the observations for the frequency response , the input voltage must be maintained constant at 20mV.
2. The frequency should be slowly increased in steps.
3. The three terminals of the transistor should be carefully identified.
4. All the connections should be correct.

RESULT:

The effect of negative feedback (Voltage -Series Feedback) on the amplifier is observed. The voltage gain and frquency response of the amplifier are obtained.Also gain-bandwidth product of the amplifier is calculated.

EXPERIMENT NO : 7

R.C.PHASE SHIFT OSCILLATOR

Aim: To design and test the RC Phase shift Oscillator for the frequency of 1KHz.

Components required:

-Transistor (BC 107)

- Resistors
- CRO
- Capacitors
- Connecting wires
- Bread board
- Power supply

Design:

$V_{CC} = 12V$

$I_C = 2mA$

$V_{RC} = 40\%\ V_{CC} = 4.8V$

$V_{RE} = 10\%\ V_{CC} = 1.2V$

$V_{CE} = 50\%\ V_{CC} = 6V$

To find R_C, R_1, R_E & R_2

We Have,

$V_{RC} = I_C R_C = 4.8V$

$R_C = 2.4K\Omega$

Choose $R_C = 2.2K\Omega$

$V_{RE} = I_E R_E = 1.2V$

$R_E = 600\Omega$

Choose $R_E = 680\Omega$

$h_{fe} = 100$ (For BC 107)

$I_B = \frac{I_C}{h_{fe}} = 20mA$

Assume current through $R_1 = 10\ I_B$ & through $R_2 = 9\ I_B$

$VR_1 = V_{CC} - V_{R2}$

$= 10V$

Also, $VR_1 = 10\ I_B\ R_1 = 10.1V$

$R_1 = 50K\Omega$

Choose $R_1 = 47K\Omega$

$VR_2 = V_{BE} + V_{RE}$

$= 0.7 + 1.2$

$= 1.9V$

Also, $VR_2 = 9\ I_B\ R_2 = 1.9V$

$R_2 = 10.6K\Omega$

Choose $R_1 = 12K\Omega$

To find C_C & C_E

$$X_{CE} = \frac{1}{2\pi C_E} = \frac{1}{10} R_E = \frac{680}{10} = 68\Omega$$

For $\vartheta = 20Hz$

$C_E = 117\mu F$

Choose $C_E = 220\ \mu F$

$$X_{CC} = \frac{1}{2\pi C_C} = \frac{R_C}{10} = 220\Omega$$

For $\vartheta = 20Hz$

Choose $C_C = 47\ \mu F$

Design of ϑ Selective Circuit:

Required ϑ of oscillations f = 1KHz

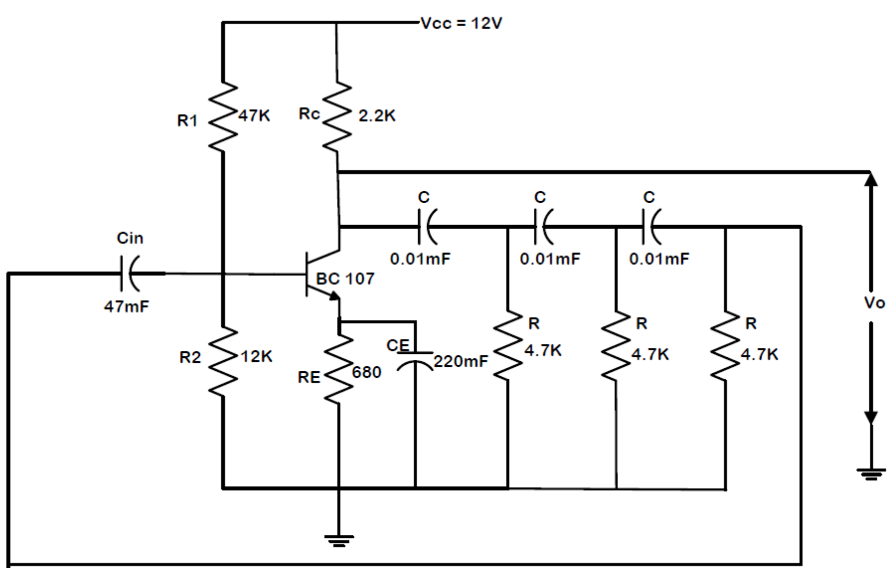
$$f = \frac{1}{2\pi R_{C\sqrt{6}+\frac{4R_C}{R}}}$$

Take R= 4.7KΩ & C=0.01µF

Procedure:

- Rig up the circuit as shown in the figure
- Observe the sinusoidal output voltage.
- Measure the frequency and compare with the theoretical values.

Circuit Diagram:



RESULT:

Frequency

Theoretical: 1KHz

Practical: _________

EXPERIMENT NO : 8

CHARACTERISTICS OF VOLTAGE REGULATORS

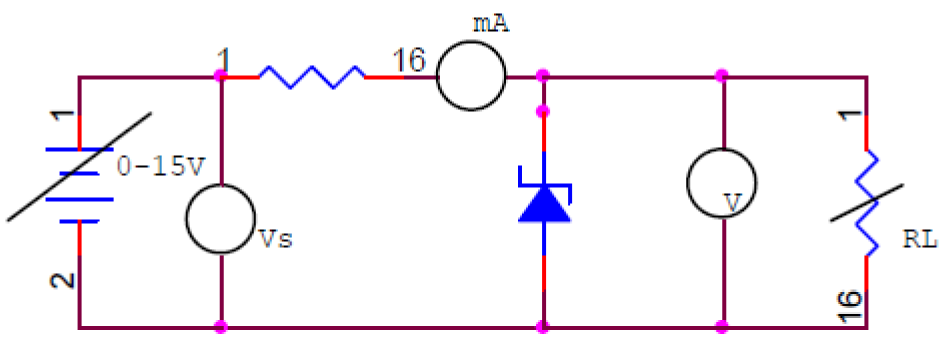
A) SIMPLE ZENER VOLTAGE REGULATORS

AIM: **To study zener diode as voltage regulator.**

APPRATUS REQUIRED: Power Supply, Zener Diode, Two Voltmeter and connected leads Ammeter.

BRIEF THEORY:- The Zener diode is operated in the breakdown or zener region, the voltage across it is substantially constant for a large current of current through it. This characteristic permits it to be used as a voltage regulator. As the lode Current increases, the Zener current decrease so that current through resistance Rs is constant. As out put voltage = Vin – Irs, and I is constant, Therefore, output Voltage remains unchanged. The input voltage Vin increase, more current will flow through the zener, the voltage drop across Rs will increase but lode voltage would remain constant.

CIRCUIT DIAGRAM:



PROCEDURE:

(a)Connect the circuit as per the circuit diagram
(b)Keep load resistance constant (take maximum value of load resistance)
(c)Vary input voltage and note down output voltage
(d)Now keep input voltage constant and vary load resistance and note down corresponding voltmeter reading
(e)Plot the respective graph

OBSERVATION TABLE:

S. No	Vs(VOLT)	V(VOLT)	RL(E)	V (VOLT)
1				
2				
3				
4				
5				
6				
7				
8				
9				

B) ZENER REGULATOR WITH EMITTER FOLLOWER OUTPUT

Aim

To study the performance of zener diode regulator with emitter follower output and to plot line regulation and load regulation characteristics.

Components and equipment required

Transistor, zener diode, resistor, rheostat,
dc source, voltmeter, ammeter and bread board.

Theory

The limitations of an ordinary zener diode regulator are, the changes in current owing through the zener diode cause changes in output voltage, the maximum load current that can be supplied is limited and large amount of power is wasted in zener diode and series resistance.

These defects are rectified in a zener regulator with emitter follower output. It is a circuit that combines a zener regulator and an emitter follower. The dc output voltage of the emitter follower is V_o = VZ - VBE. When input voltage changes, zener voltage remains the same and so does the output voltage.

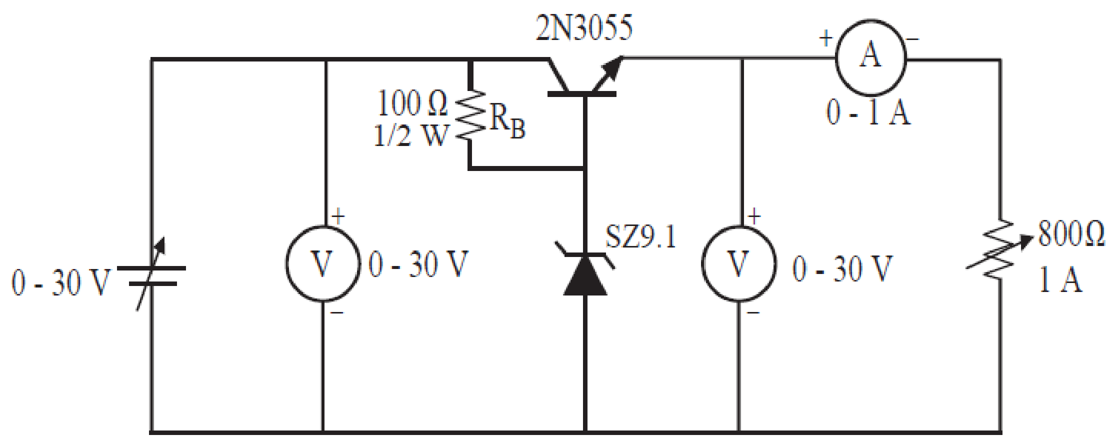
In an ordinary zener regulator, if the load current IL required is in the order of amperes, zener diode should also have the same current handling capacity. But in zener regulator with emitter follower output, current owing through the zener is IL/ß.

Another advantage of this circuit is low output impedance.

The expression for the output voltage can also be expressed as V_ = Vi-VCE. This means that when the input voltage increases, output remains constant by dropping excess voltage across the transistor.

The limitation of this circuit is that the output voltage directly depends on the zener voltage. This is rectified in the series voltage regulator with feedback using error amplifier.

Circuit diagram



Procedure

1. Set up the circuit on the bread board after identifying the component leads. Verify the circuit using a multimeter.

2. Note down output voltage by varying the input voltage from 0 V to 30 V in steps of 1 V. Plot line regulation characteristics with Vi along x-axis and V_i along y-axis. Calculate percentage line regulation using the expression $\Delta Vo/\Delta Vi$.

3. Keep the input voltage at 15 V and note down output voltage by varying load current from 0 to 500 mA in equal steps using a rheostat. Plot load regulation characteristics with IL along x-axis and V_O along y-axis.

4. Measure the full load voltage VFL by adjusting the rheostat until ammeter reads 500 mA.

5. Remove the rheostat and measure the output voltage to get no-load voltage VNL.

6. Mark VNL and VFL on the load regulation characteristics and calculate load

regulation as per the equation,

$$V_R = \frac{V_{NL} - V_{FL}}{V_{NL}} 100\%$$

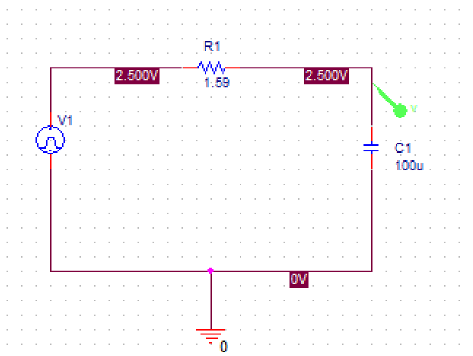
I_L (A)	V_L (V)

RESULT

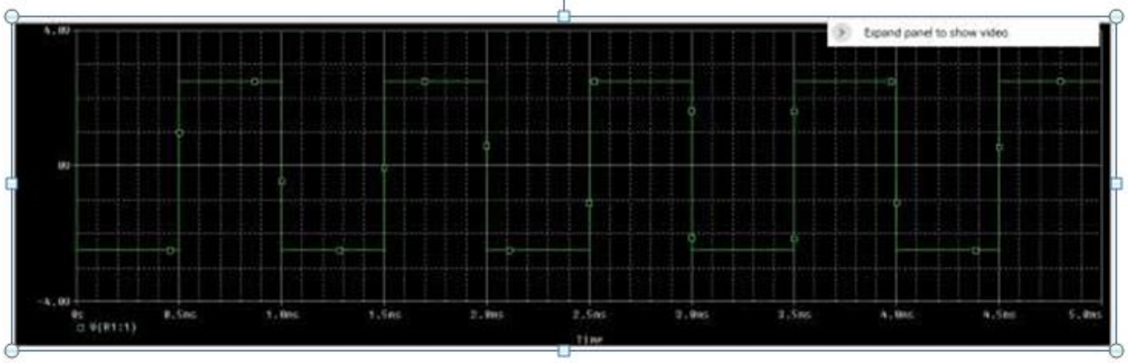
1.INTEGRATOR

TRANSIENT RESPONSE

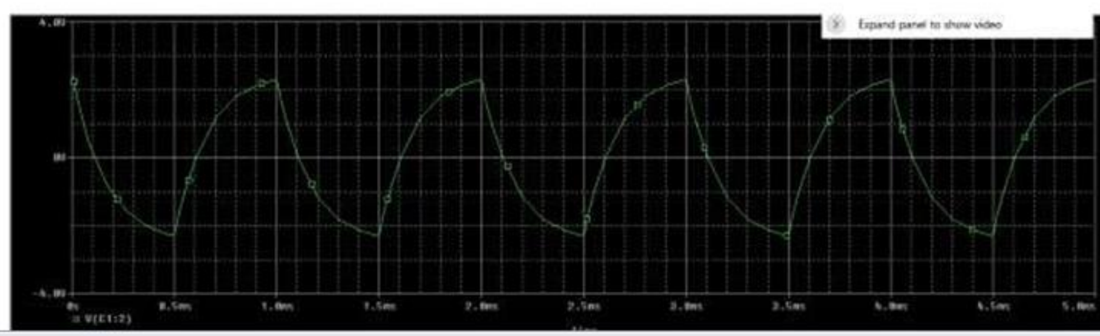
Circuit Diagram



Input



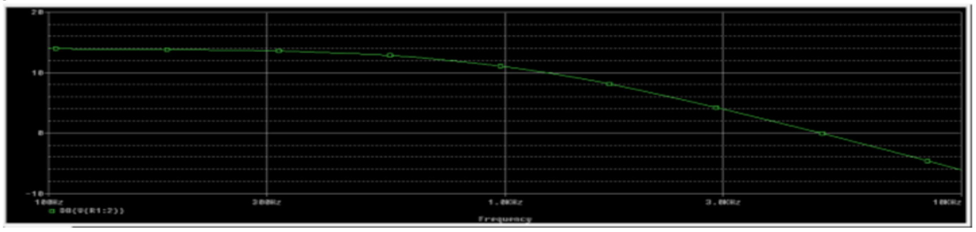
Output



FREQUENCY RESPONSE (LPF)

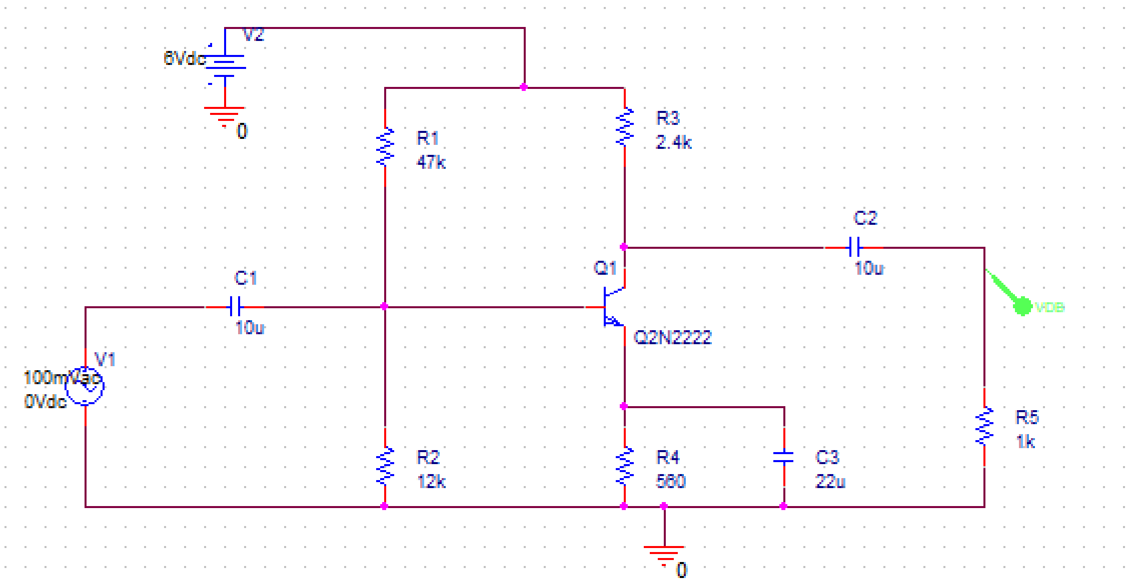
Output

Output

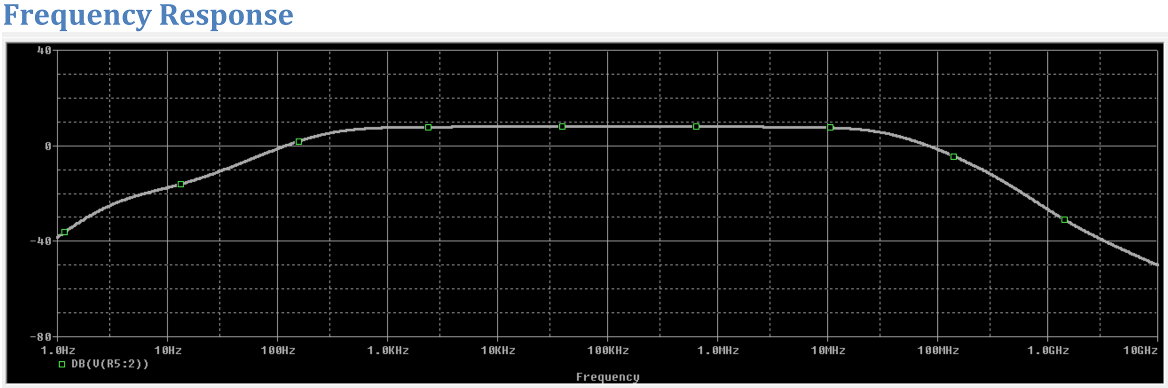


2. RC COUPLED AMPLIFIER

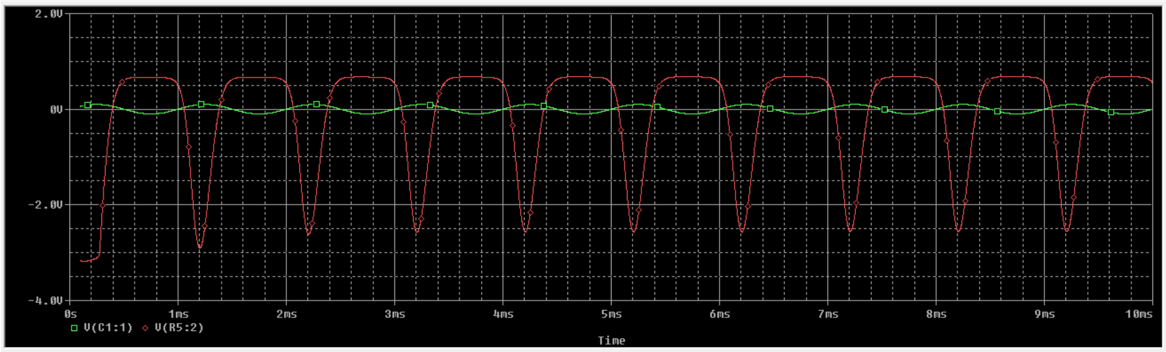
CIRCUIT DIAGRAM



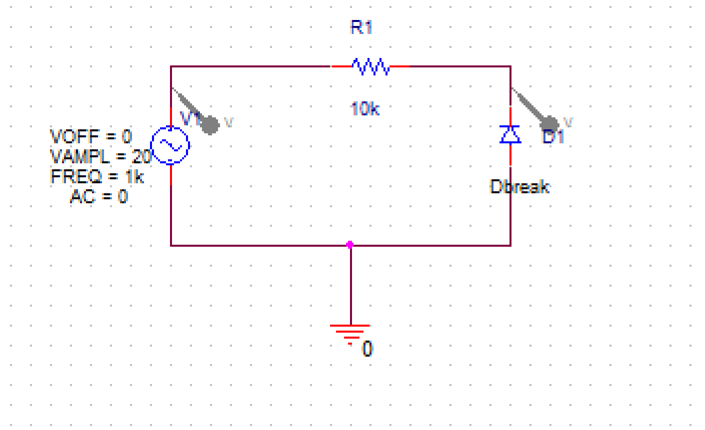
Frequency Response

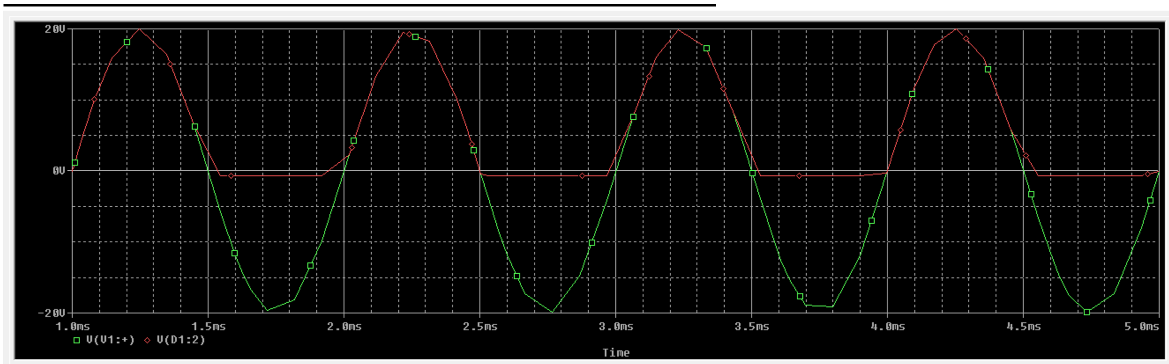


Transient Response

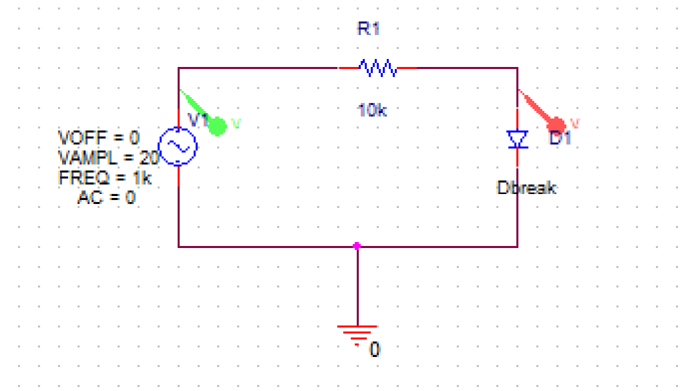


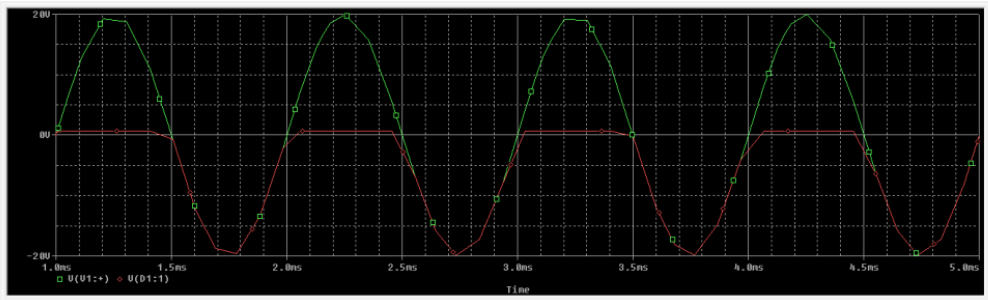
3.Negative Clipper



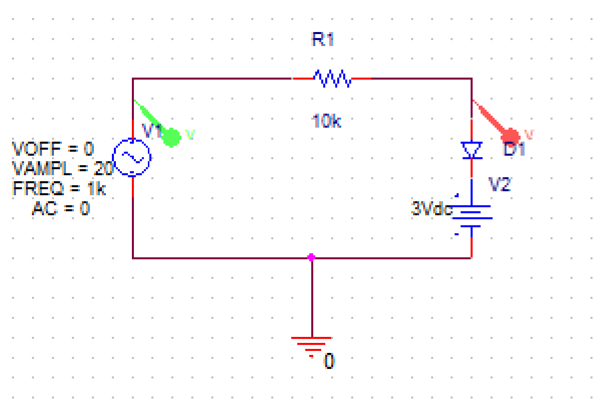


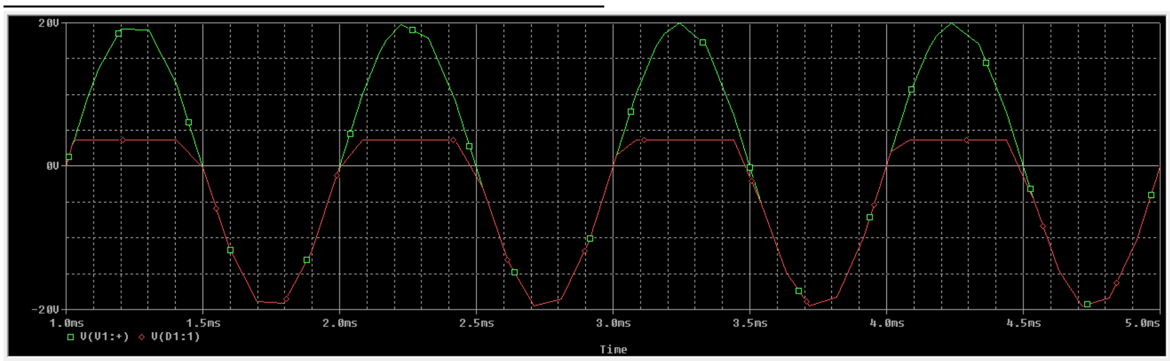
Positive Clipper



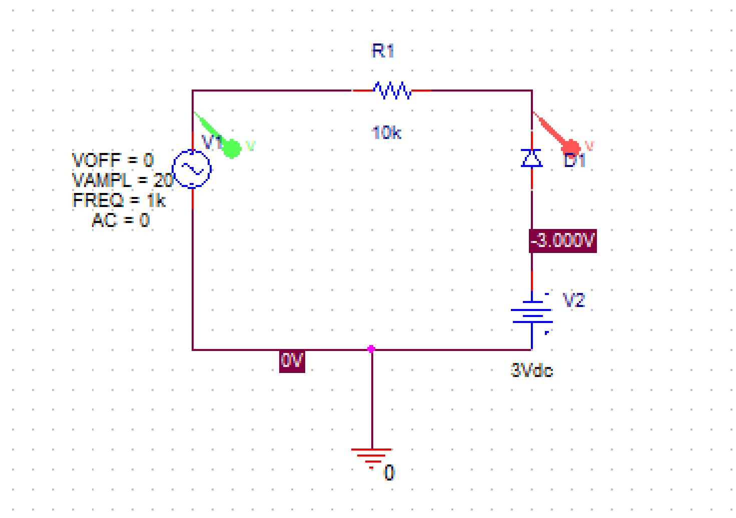


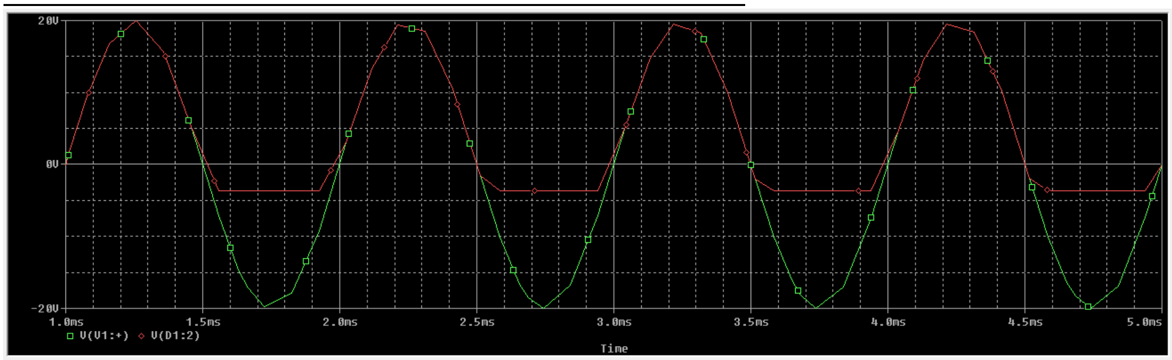
Positive Clipper with clipping level at 3V



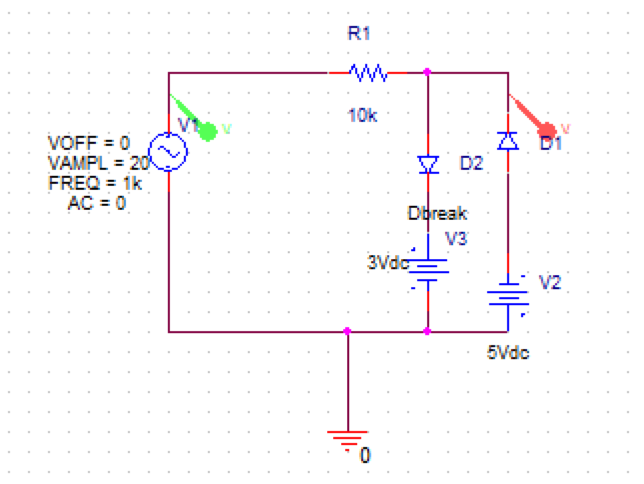


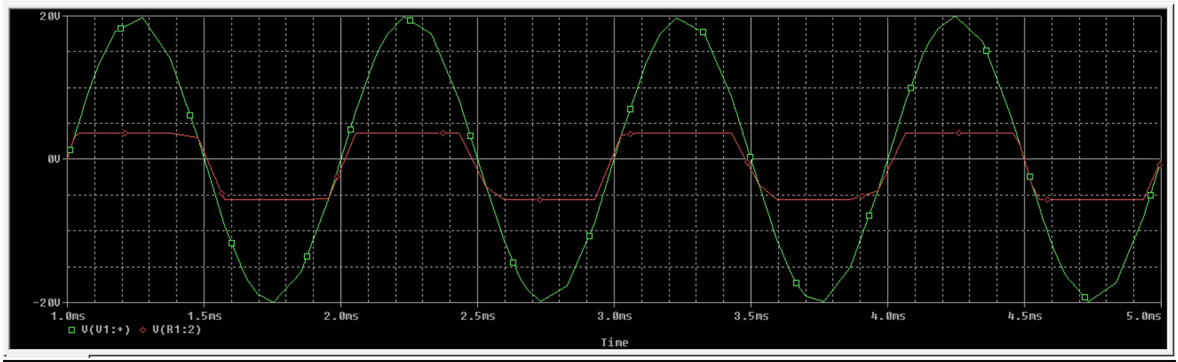
Negative Clipper with clipping level at -3V





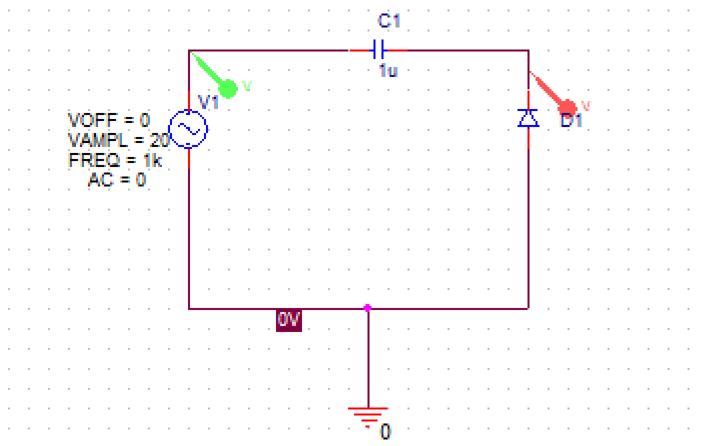
Double clipper with clipping level -5V &+3V

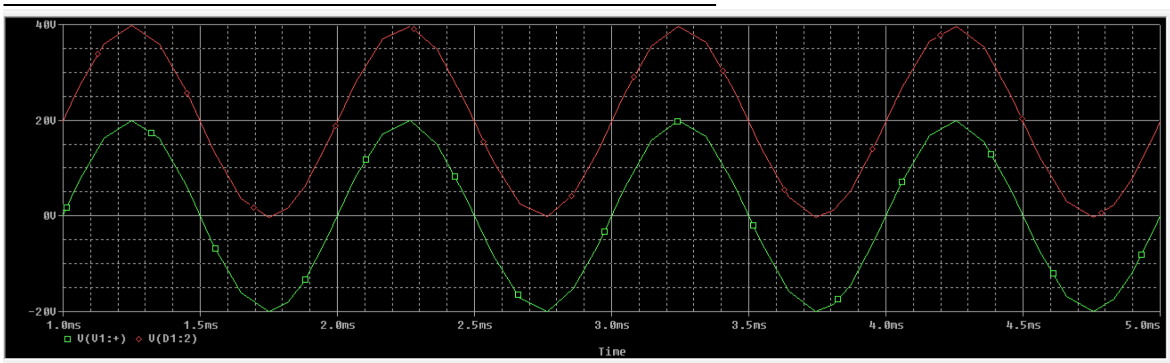




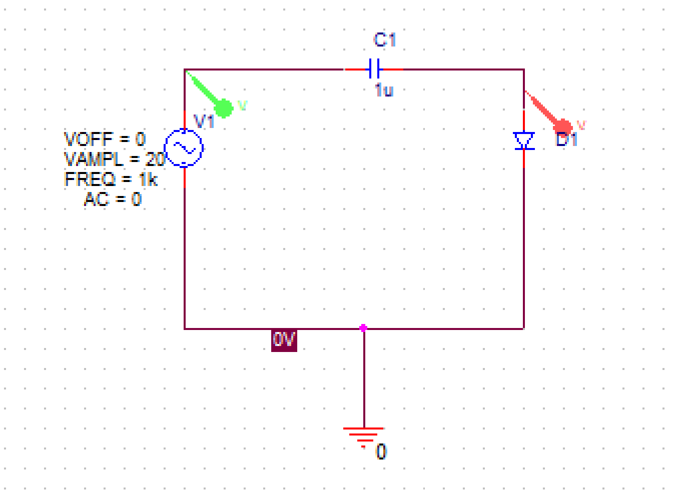
4.CLAMPERS

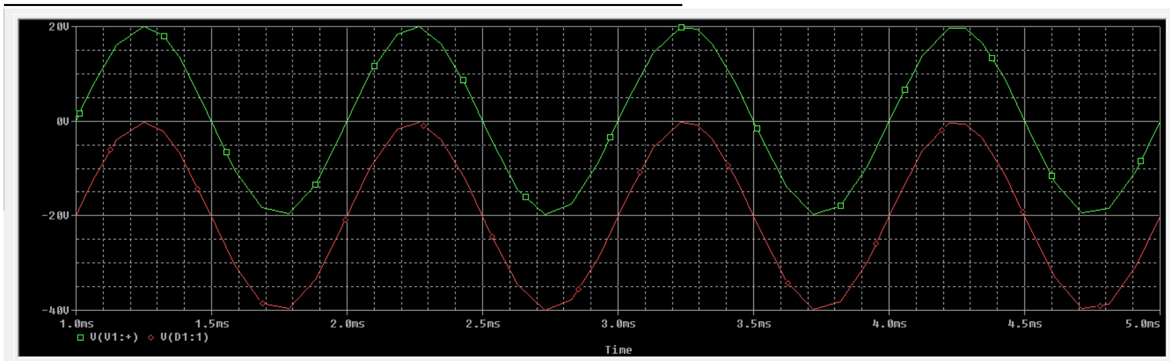
Clamper clamping positively at 0V



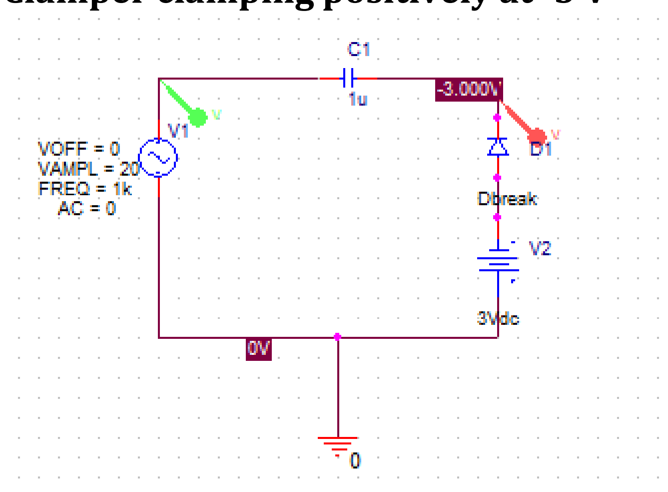


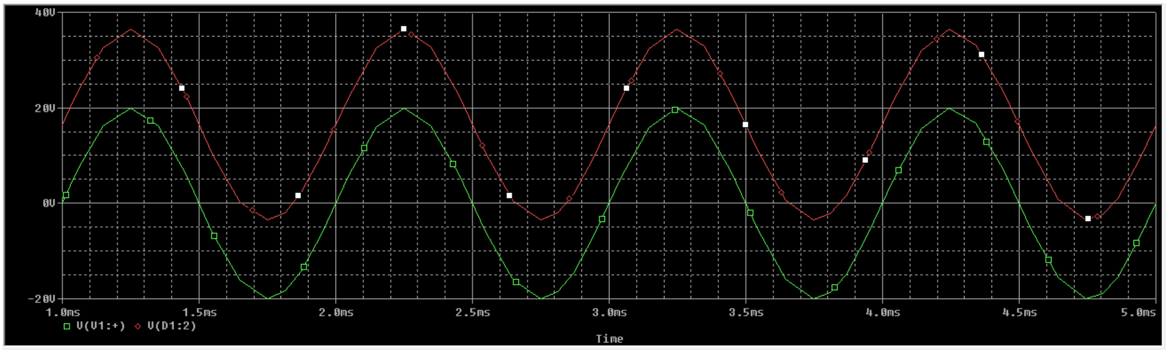
Clamper clamping negatively at 0V



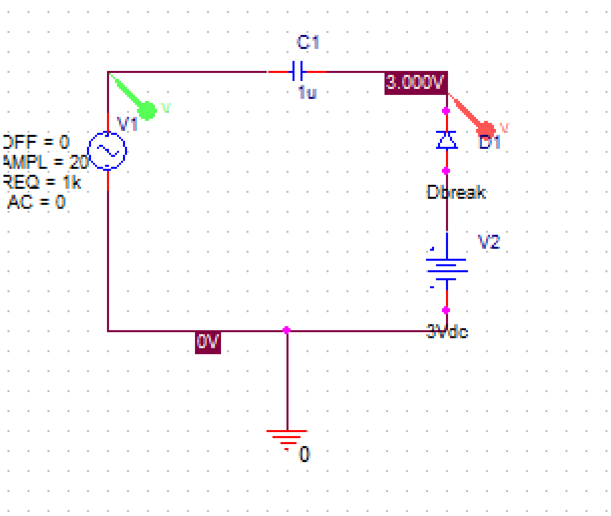


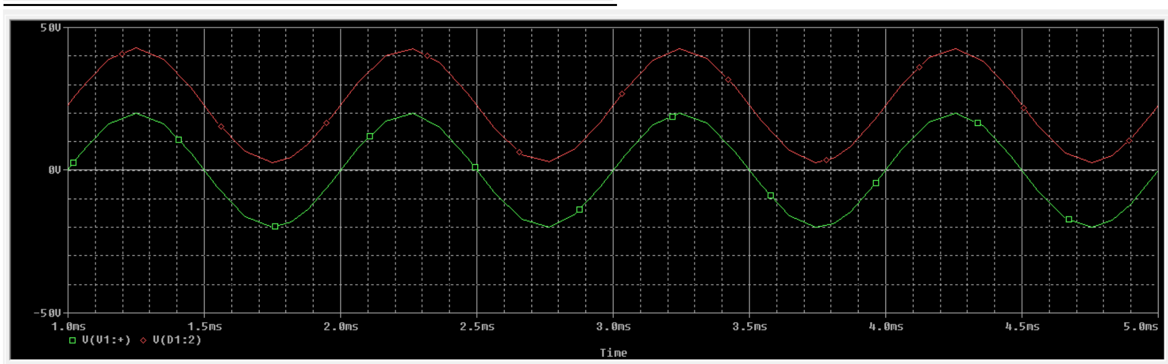
Clamper clamping positively at -3 V



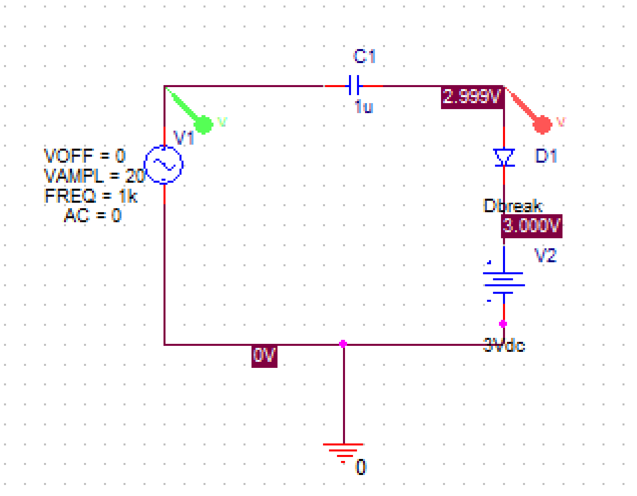


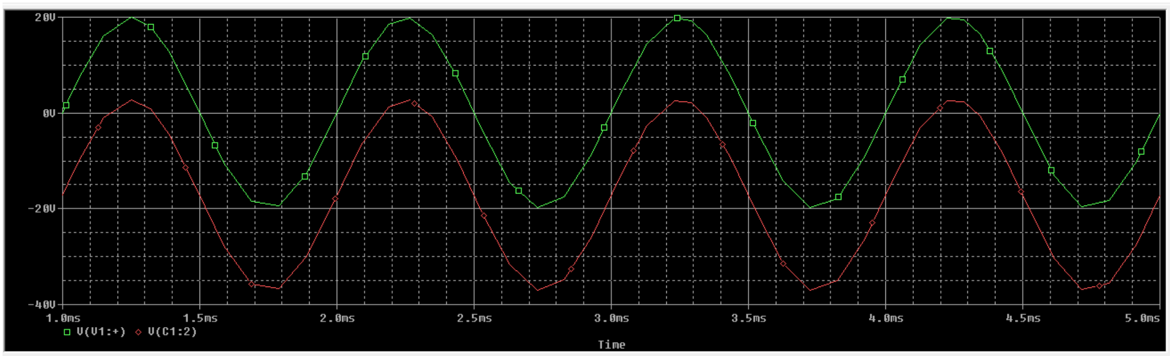
Clamper clamping positively at 3V



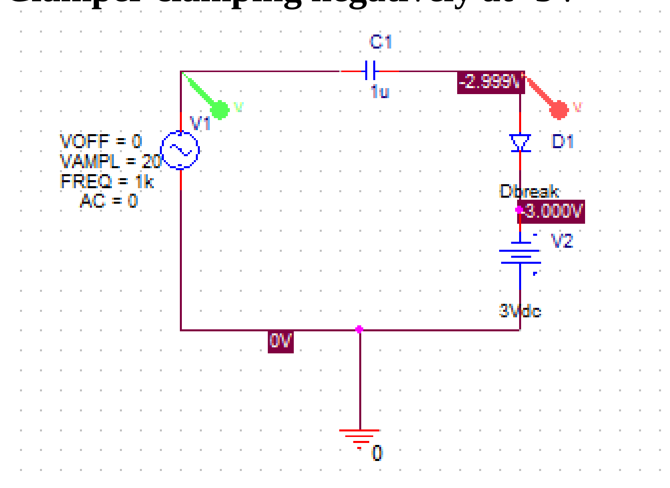


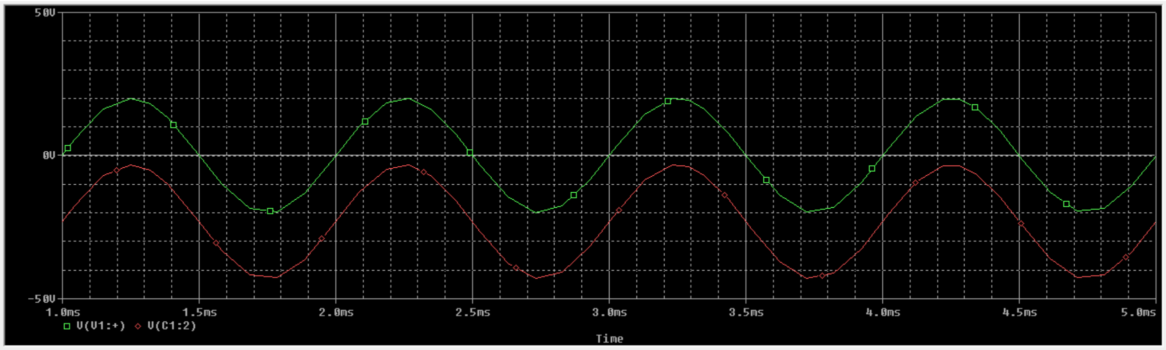
Clamper clamping negatively at 3V





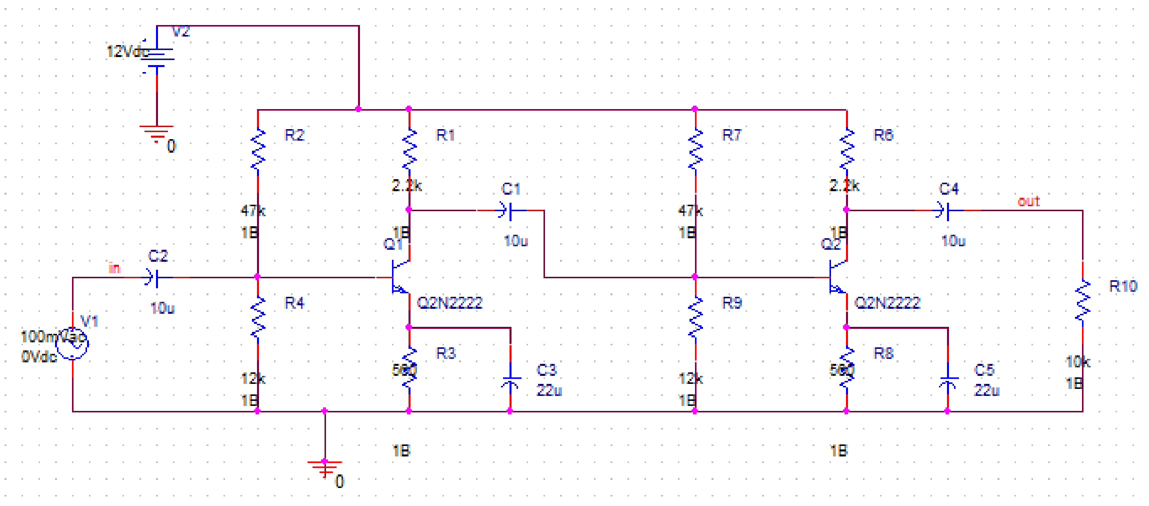
Clamper clamping negatively at -3V



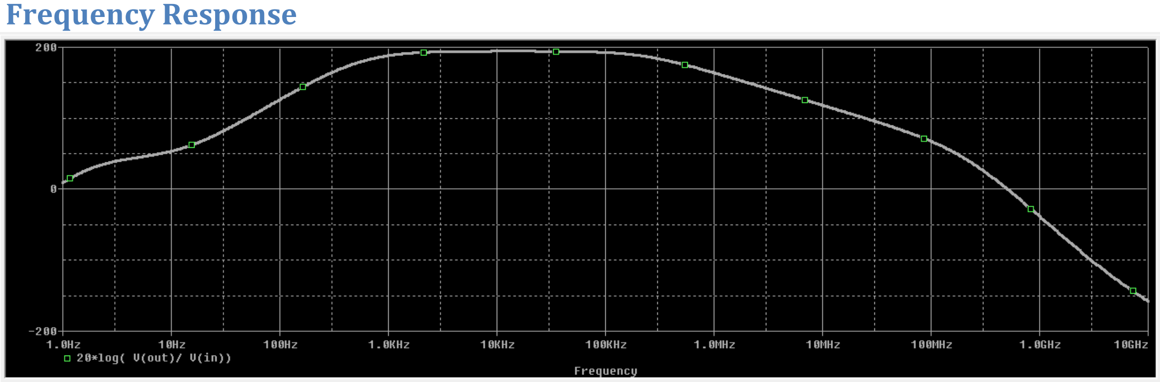


5. MULTI STAGE AMPLIFIER

CIRCUIT DIAGRAM

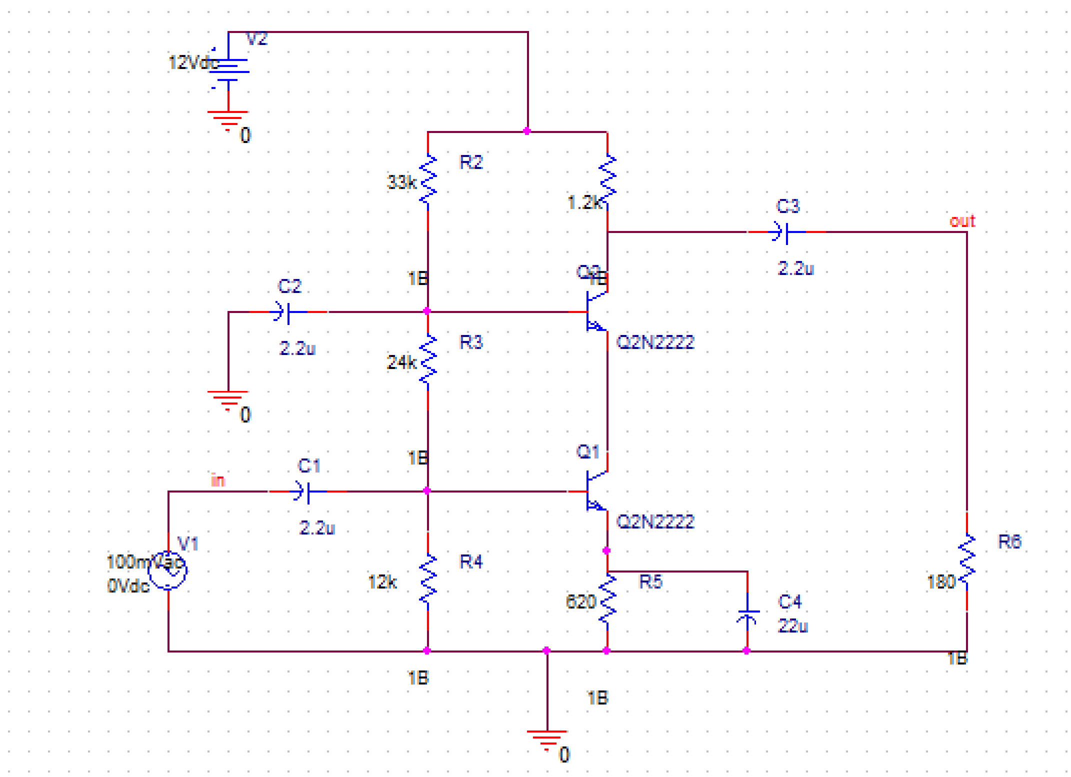


Frequency Response



6.CASCODE AMPLIFIER

Circuit Diagram



Frequency Response