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 MECHATRONICS

LAB MANUAL

EC 235 ANALOG ELECTRONICS LABORATORY

VISION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

MD 1: The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.

MD 2: The department is committed to impart the awareness to meet the current challenges in technology.

MD 3: Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society.

PROGRAMME EDUCATIONAL OBJECTIVES

PEO1: Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

PEO2: Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

PEO3: Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

PEO4: Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

PROGRAM OUTCOMES (PO'S)

Engineering Graduates will be able to:

PO 1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO'S)

PSO 1: Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

PSO 2: Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

COURSE OUTCOME

C209.1	To acquire the basic knowledge about CRO by the measurement of current, voltage, frequency and phase shift.
C209.2	Develop working knowledge on rectifier circuits and its characteristics, diode clipping and clamping circuits.
C209.3	To acquire the basic knowledge about RC coupled amplifier by measuring gain, impedance & frequency response.
C209.4	Develop working knowledge on FET amplifiers by measuring gain & impedance.
C209.5	Experimentally test the working of voltage series feedback amplifier.
C209.6	Develop a working knowledge on voltage regulators, multivibrators & RC phase shift oscillator

CO VS PO'S AND PSO'S MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS0 1	PSO 2
C209.1	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**2**	**2**
C209.2	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**2**	**2**
C209.3	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**
C209.4	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**2**
C209.5	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**2**	**2**
C209.6	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**2**	**2**
C 209	**3.00**	**2.00**	**1.67**	**2.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.00**	**0.00**	**0.00**	**2.00**	**2.00**	**2.00**

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 permission from the faculty member for absence, which would be granted only under justifiable circumstances. 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

Course code	Course Name	L-T-P - Credits	Year of Introduction
EC235	ANALOG ELECTRONICS LABORATORY	0-0-3:1	2016

Prerequisite: EC209 Analog electronics

Course Objectives

- To develop working knowledge on electronic devices and their performance characteristics

List of Exercises/Experiments : (Ten experiments are mandatory)

1. Study & Use of CRO: Measurement of current voltage, frequency and phase shift.

2.Diode Clipping Circuits

3. Clamping Circuits

4. Rectifiers and filters with and without shunt capacitors- Characteristics full wave rectifier- Ripple factor, Rectification efficiency, and % regulation

5. RC coupled amplifier using BJT in CE configuration- Measurement of gain, input and output impedance and frequency response

6. FET amplifier- Measurement of voltage gain, current gain, input and output impedance

7. Darlington Emitter Follower

8. R.C. Phase Shift Oscillator using BJT or Op- Amp

9. Characteristics of voltage regulators- Design and testing of: a) simple zener voltage regulator b) zener regulator with emitter follower output

10. Series & Parallel Resonance Circuits

11. Voltage Series Feedback Amplifier

12. Class 'B' Push-Pull Amplifier

13. Astable and monostable multivibrators using IC 555

14. Design of PLL for given lock and capture ranges& frequency multiplication

15. Applications using PLL

List of major equipments

CRO, Function generator, Regulated power supply , Dual power supply, Digital multimeter, Ammeter ,Voltmeter.

Expected outcome.

- On completion of the course the student will be able to understand the working of electrical devices ,their performance characteristics and will be able to design circuits for various electronic devices

INDEX

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.

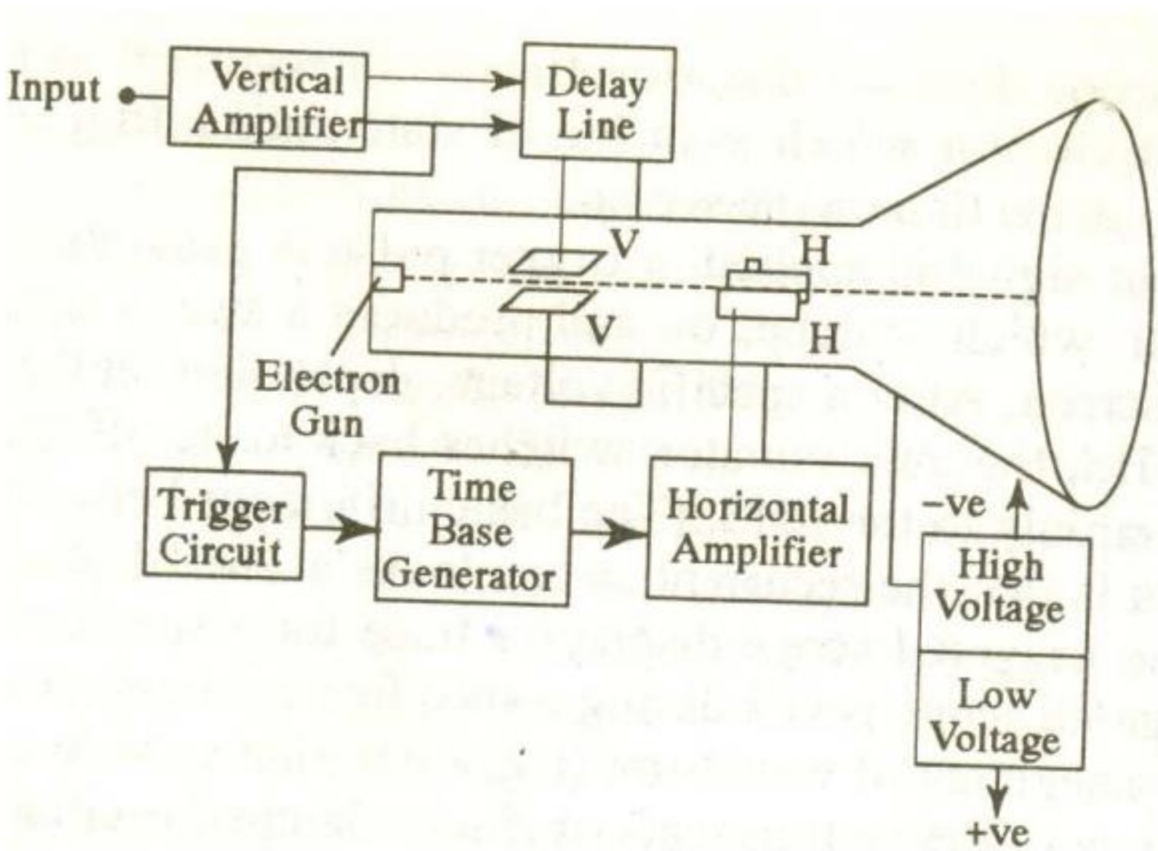


Fig:1 Block Diagram of CRO

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

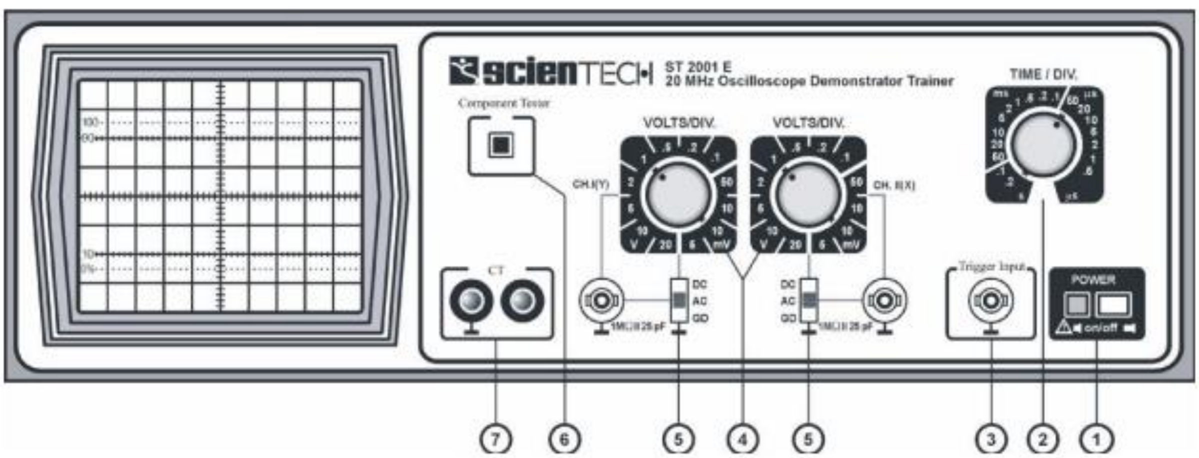


Fig:2 Front Panel of CRO

(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.

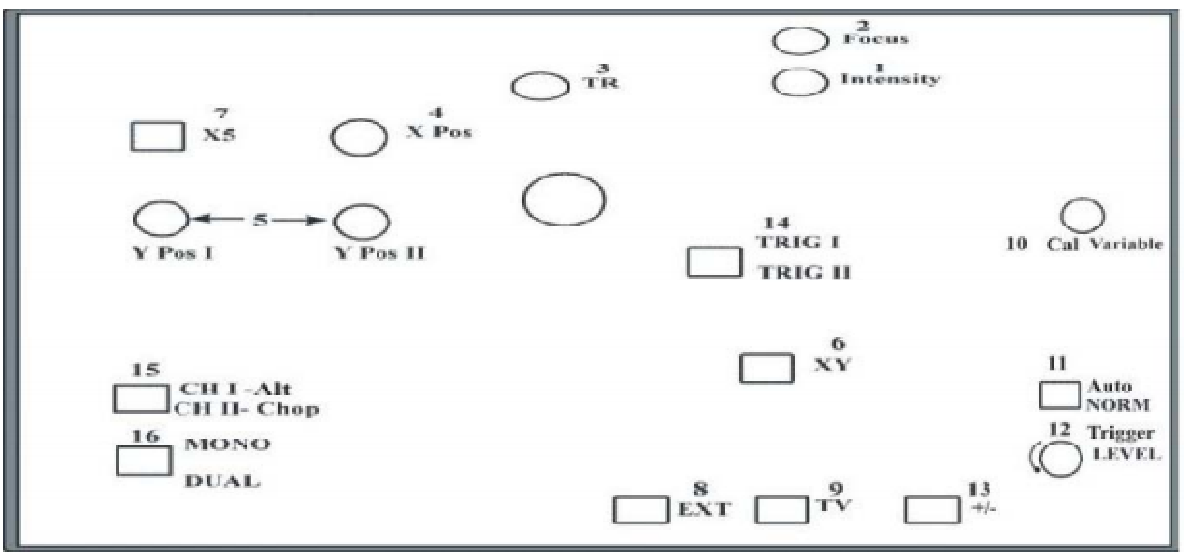


Fig:3 Controls on PCB

(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 :

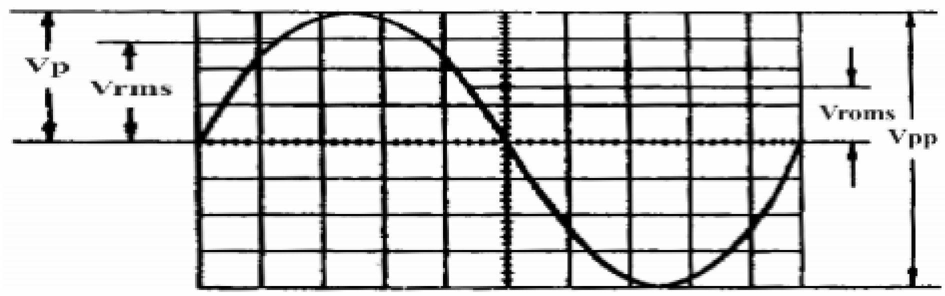


Fig:4 Amplitude measurement using CRO

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

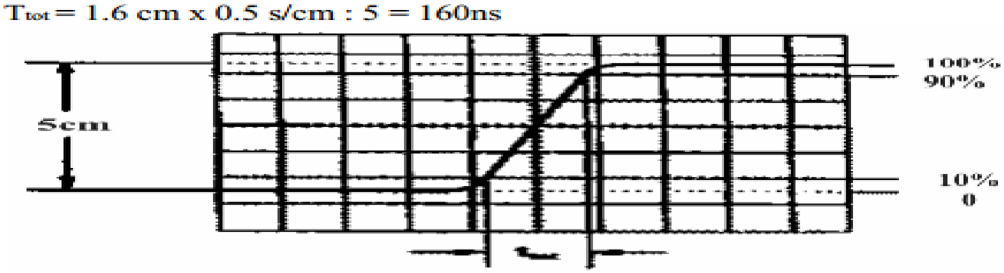


Fig:5 Frequency measurement using CRO

RESULT

EXPERIMENT NO : 2

DIODE CLIPPING CIRCUITS

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

Components required:

-Power Supply

-Diodes IN4007or BY127

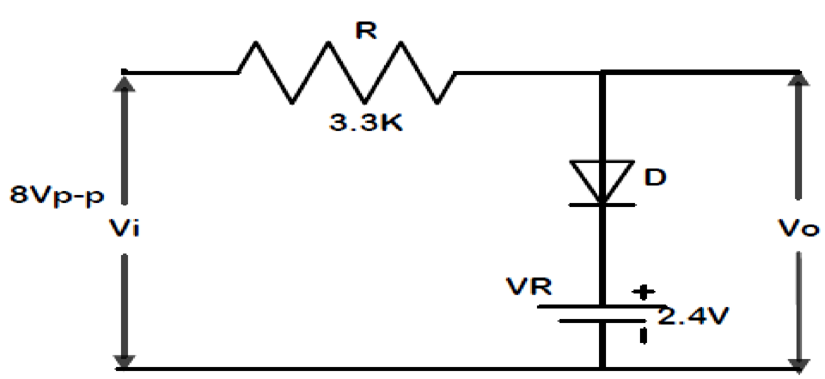
-Resistors

Procedure:

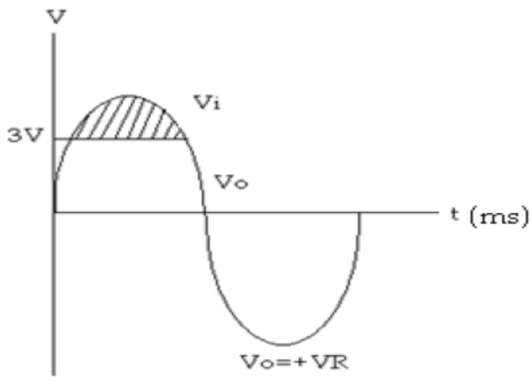
- Make the Connections as shown in the circuit diagram
- Apply sinusoidal input Vi of 1 KHz and of amplitude 8V P-P to the circuit.
- Observe the output signal in the CRO and verify it with given waveforms.
- Apply Vi and Vo to the X and Y channel of CRO and observe the transfer characteristic waveform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

I) **Positive Clipping Circuit:**

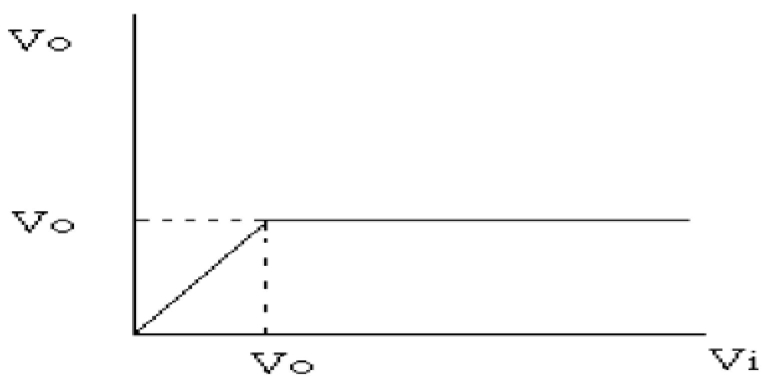
Circuit Diagram:



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

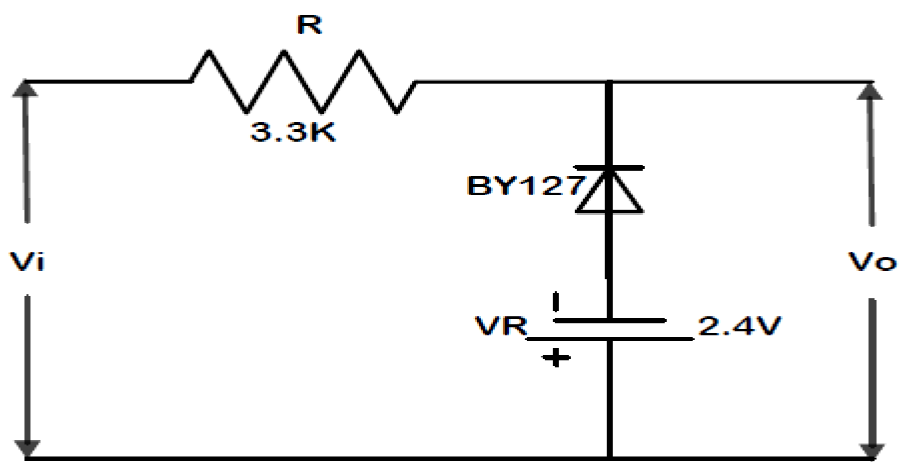
Vref = Vomax -Vr

=3 - 0.7

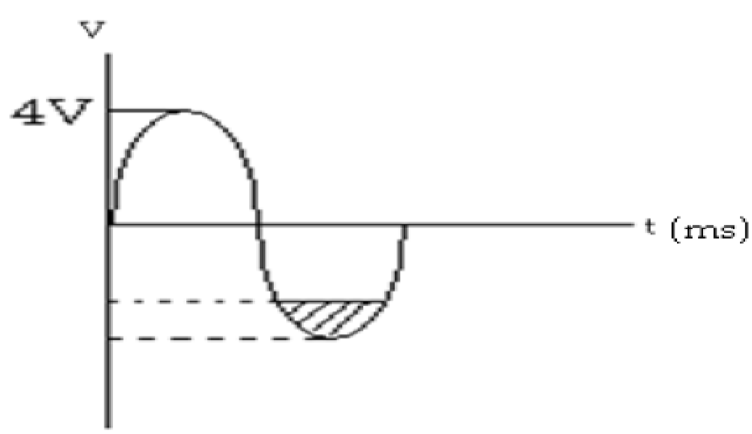
Vref = 2.3 V

II) **Negative Clipping Circuit:**

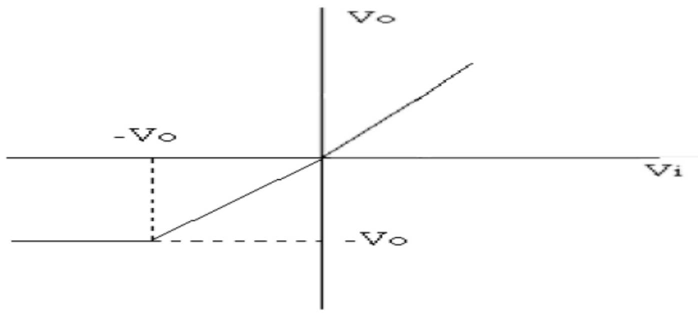
Circuit Diagram:



Waveforms:



Transfer Characteristics:



Let the output voltage be clipped at -3V

Vomin = -3V

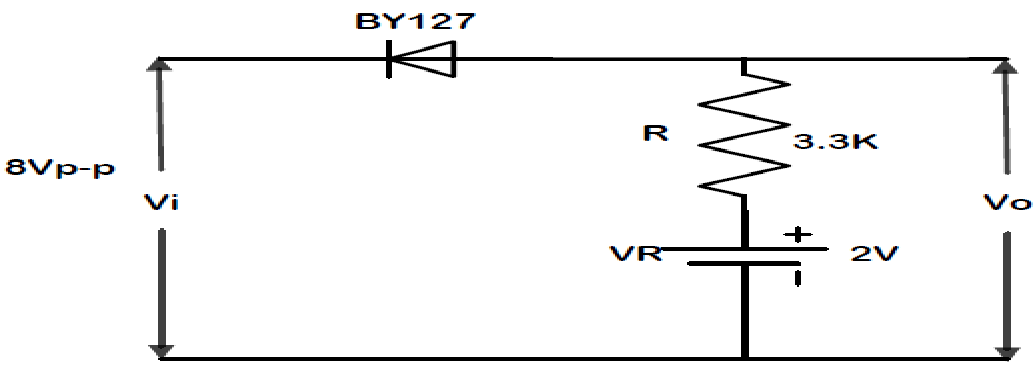
Vomin = -Vr+Vref

Vref = Vomin+Vr = -3 + 0.7

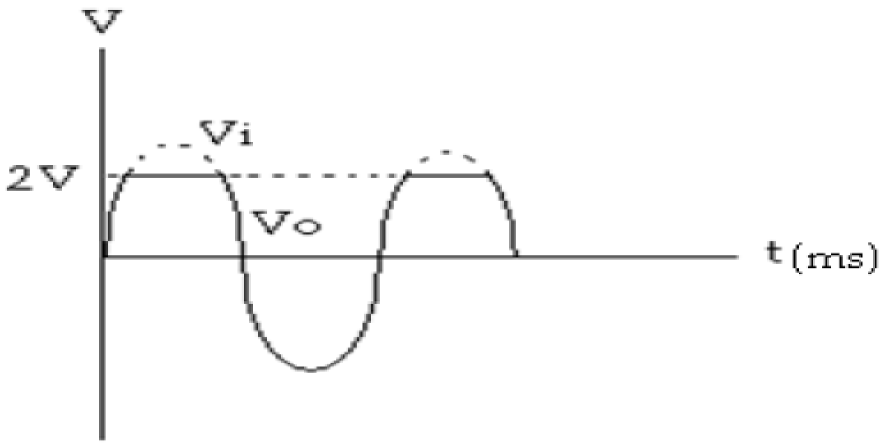
Vref = -2.3V

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

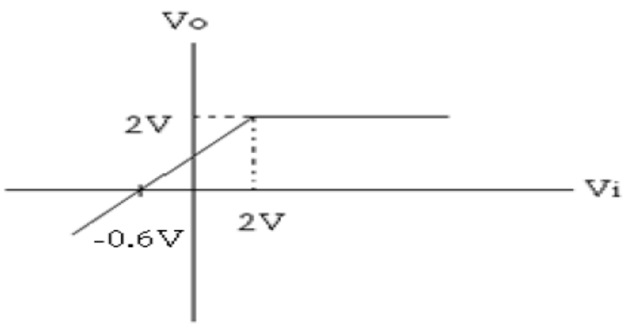
Circuit Diagram:



Waveforms:



Transfer Characteristics:

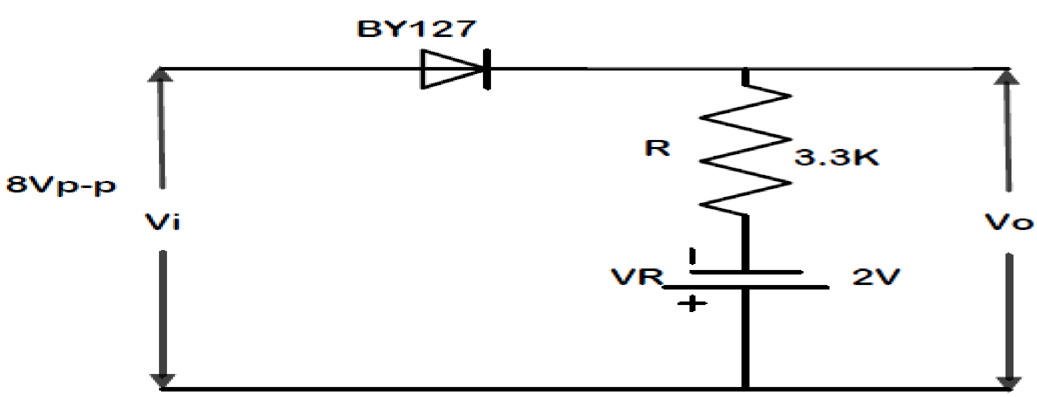


Let the output voltage be clipped at 2V

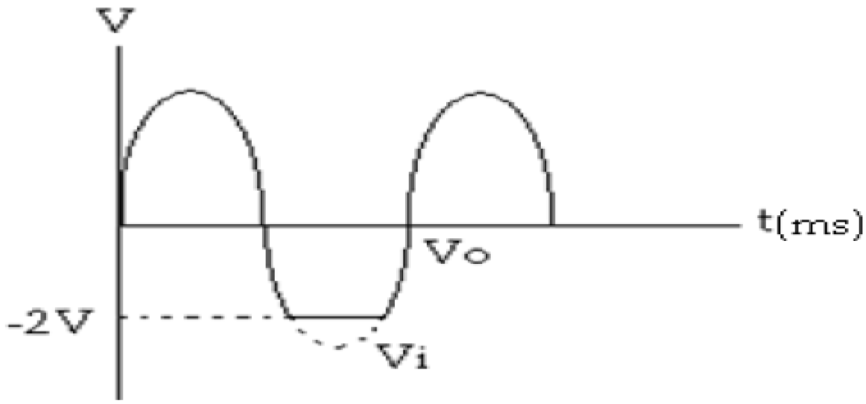
Vomax = Vref = 2V

IV) **Negative Peak Clipper:**

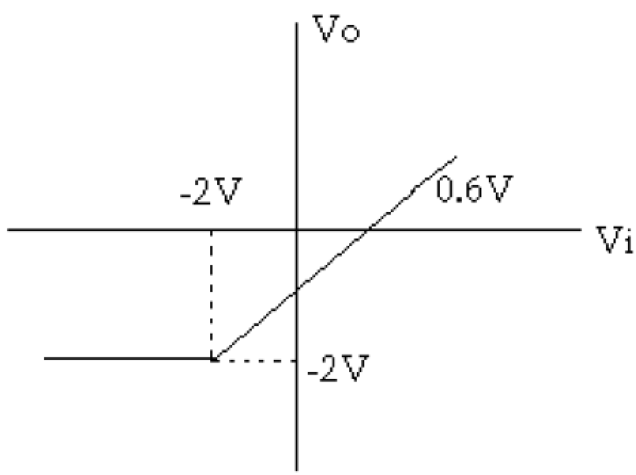
Circuit Diagram:



Waveforms:



Transfer Characteristics:

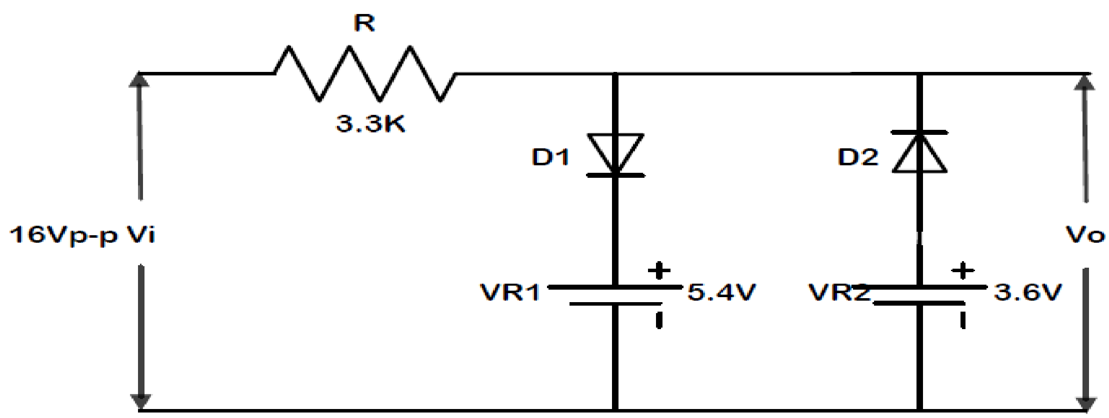


Let the output voltage be clipped at -2V

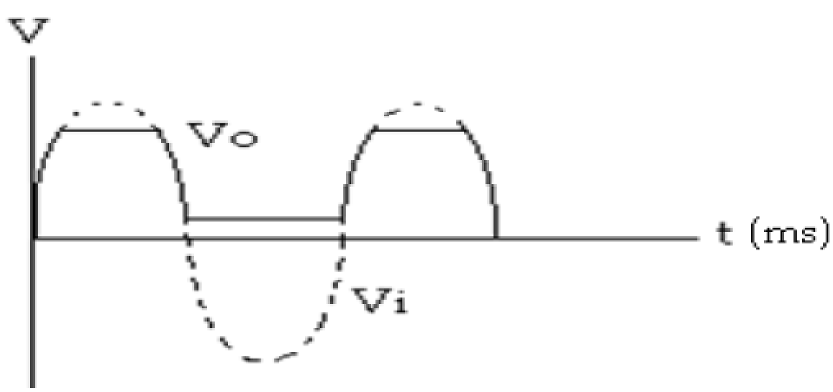
Vomin = Vref = -2V

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

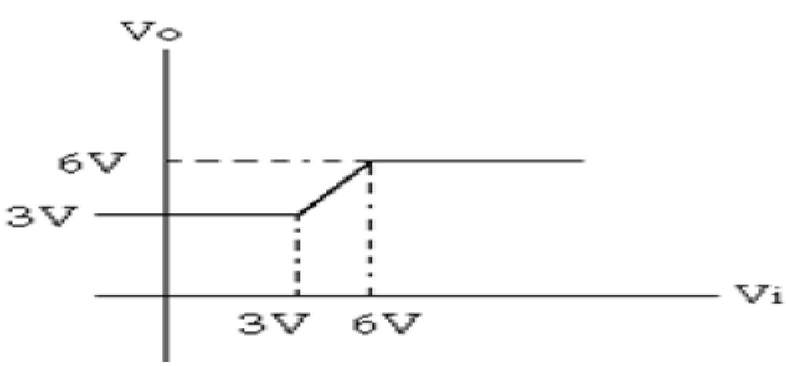
Circuit Diagram:



Waveforms:



Transfer Characteristics:



Let Vomax = 6V and Vomin = 3V

Vomax = Vr1 + Vr

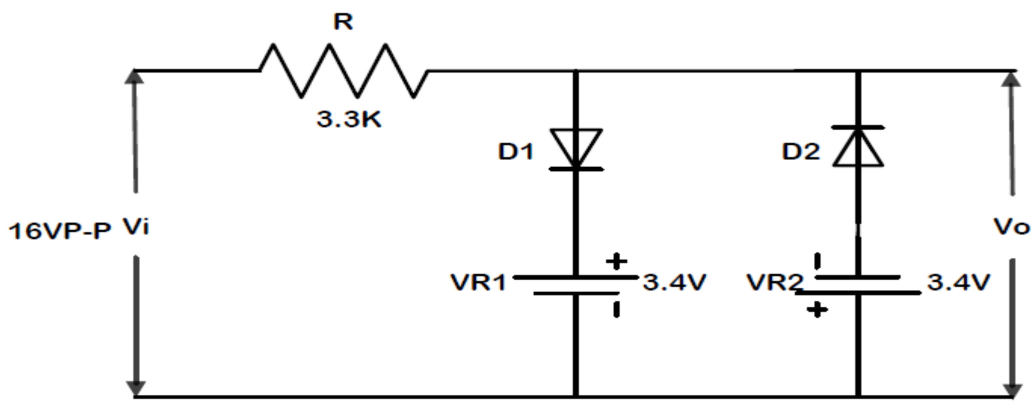
Vr1 = Vomax - Vr = 6 – 0.7 = 5.3V

Vomin = Vr2- Vr

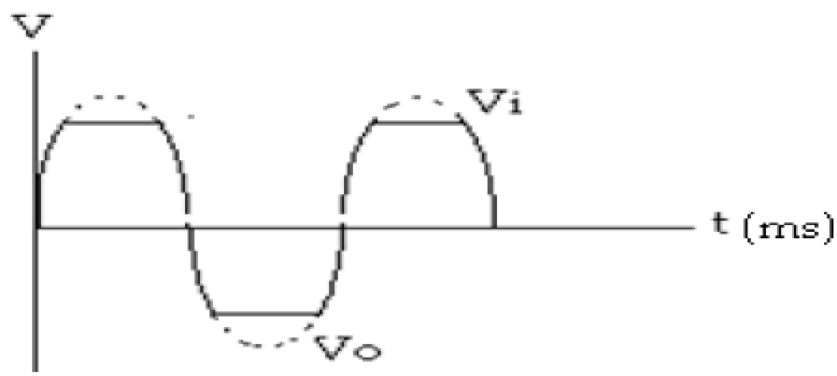
Vr2 = Vomin + Vr = 3 + 0.7= 3.7V

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

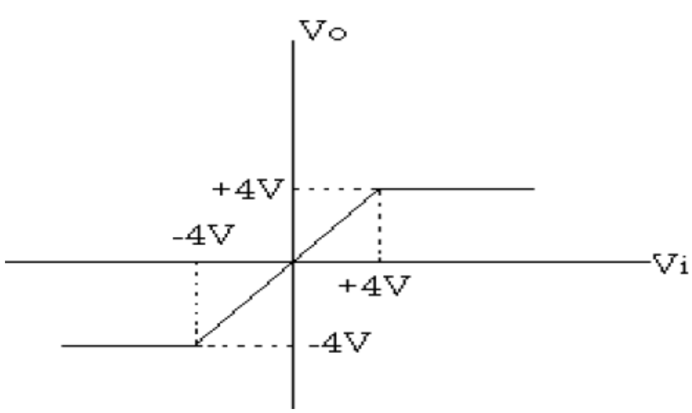
Circuit Diagram:



Waveforms:



Transfer Characteristics:



Let VR1 = VR2 = VR, Vomax = 4V

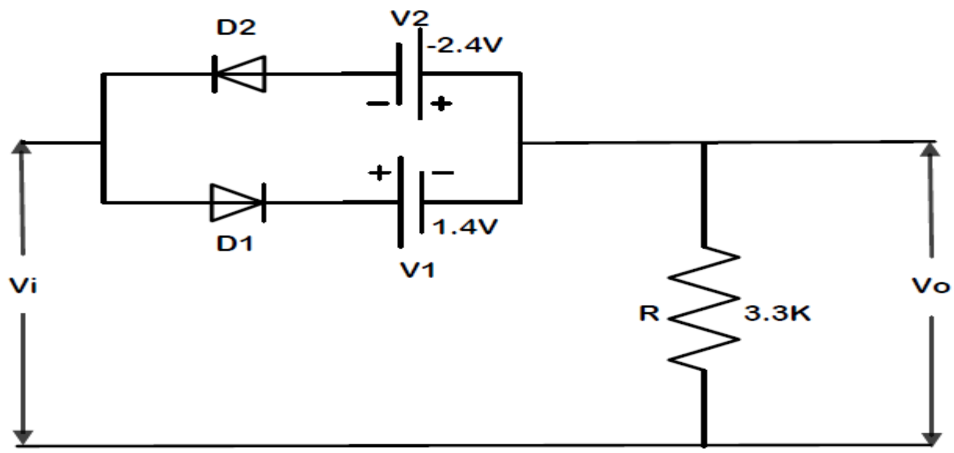
Vomax = VR + Vr

VR = Vomax – Vr = 4 – 0.7

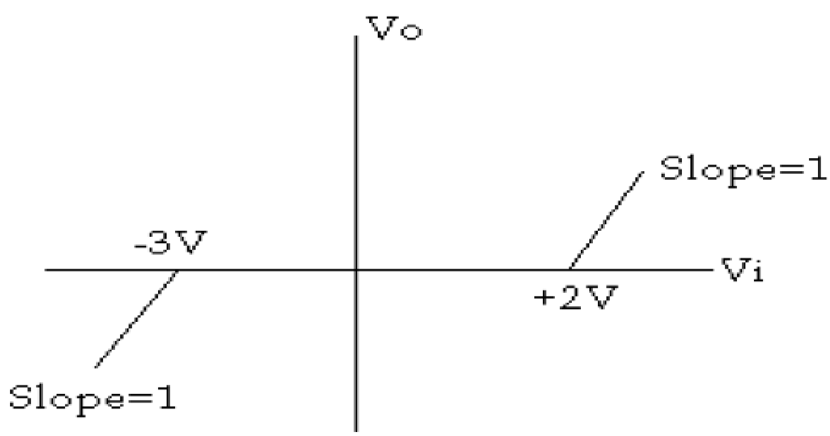
VR = 3.3V

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 : 3

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

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

$$RC \gg T$$

let T = 1ms f(1KHz)

Let RC = 10T

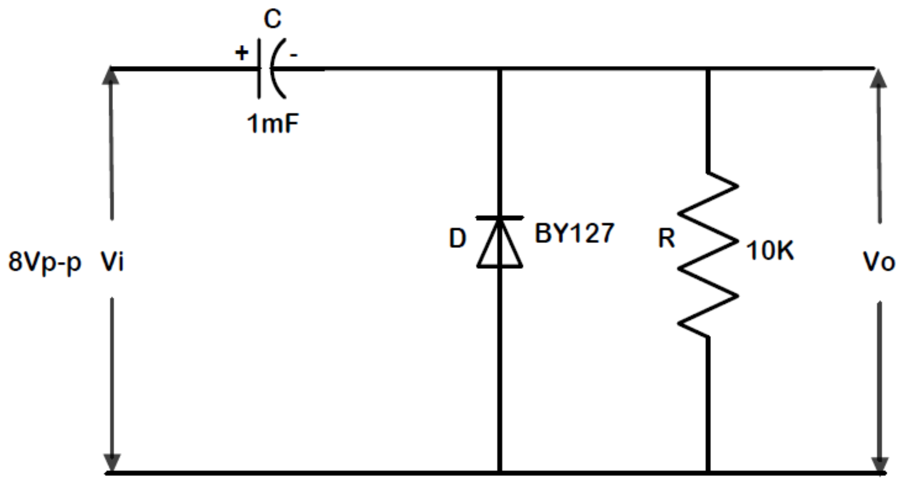
RC = 10ms

C = 1μF

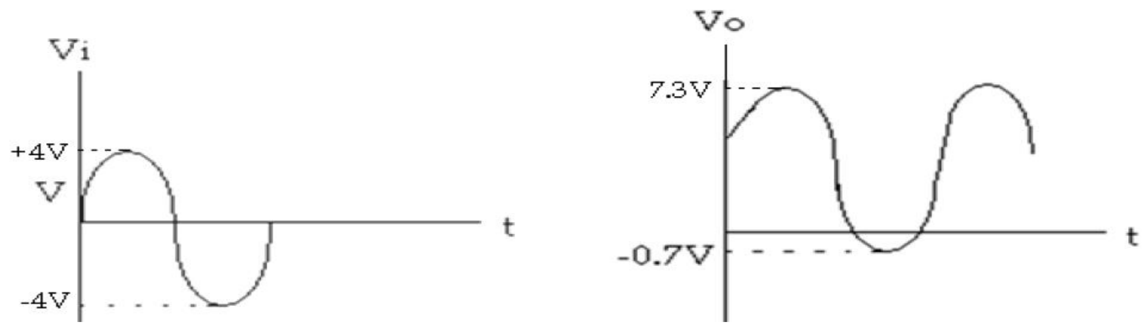
R = 10KΩ

I) **Positive Clamping Circuits:**

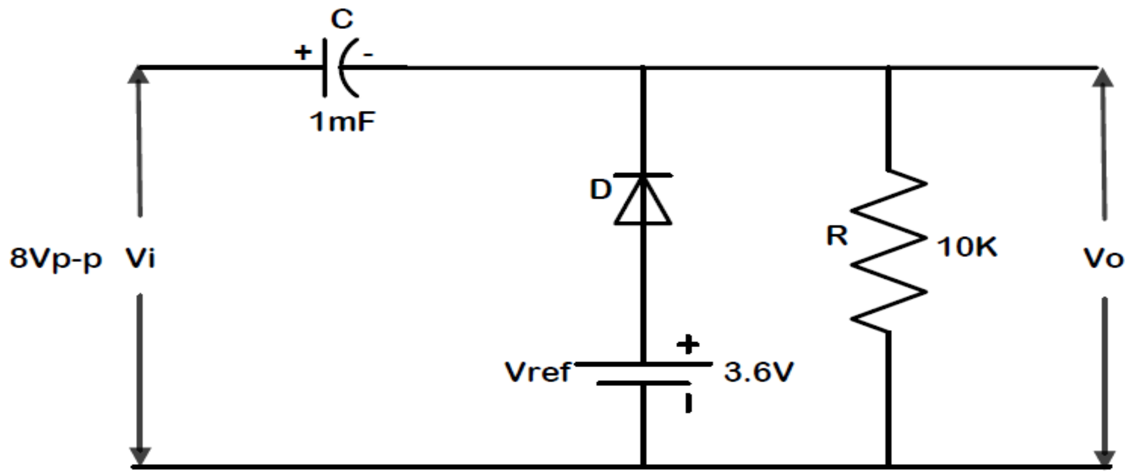
Circuit Diagram:



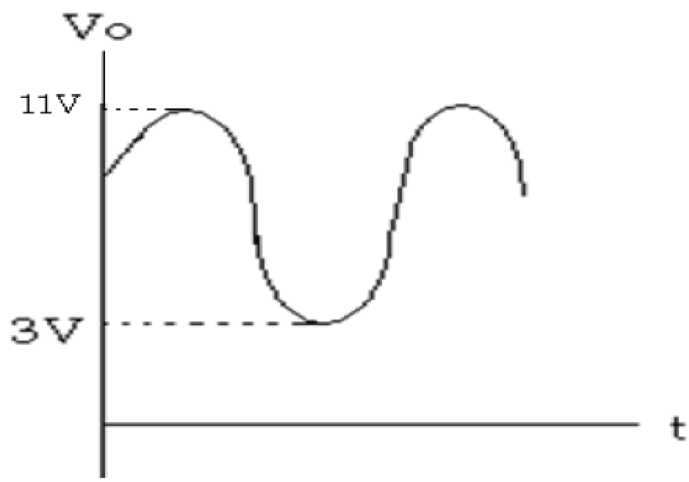
Waveforms:



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



Waveforms:



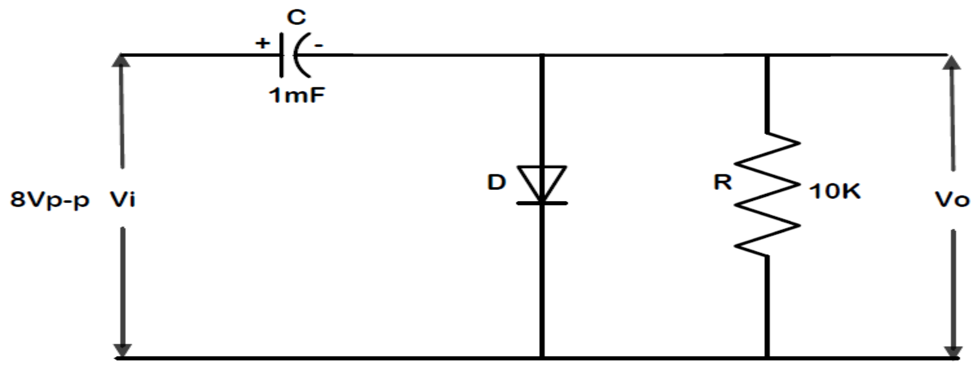
$$V_o = V_{\vartheta} + V_{ref}$$

3 = -0.7 + Vref,

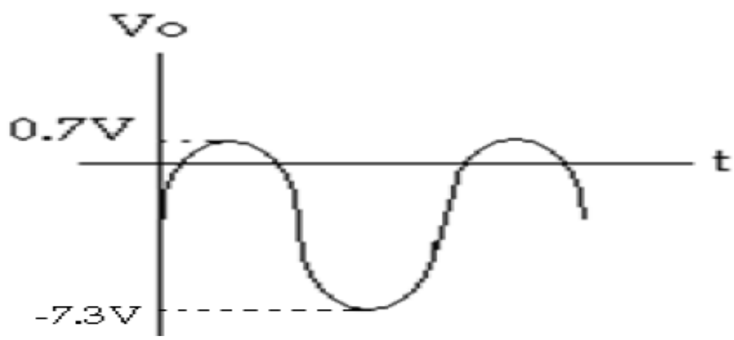
Vref = 3.7

III) **Negative Clamping Circuit:**

Circuit Diagram:

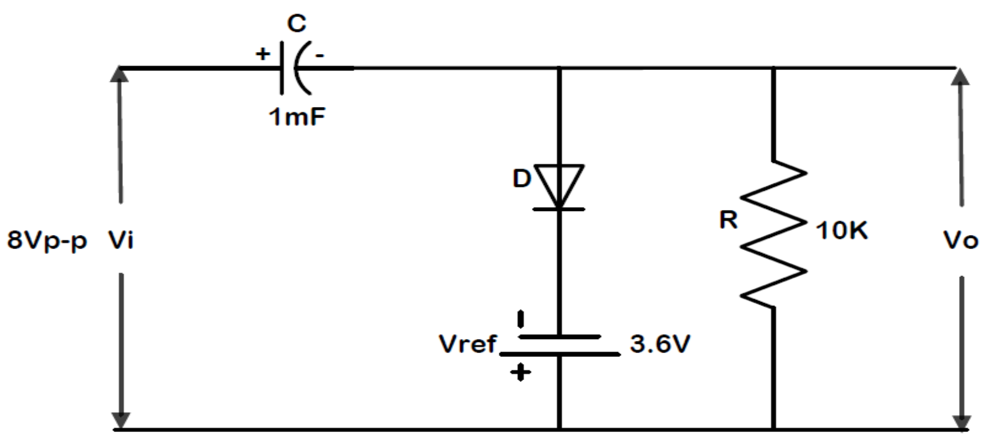


Waveforms:

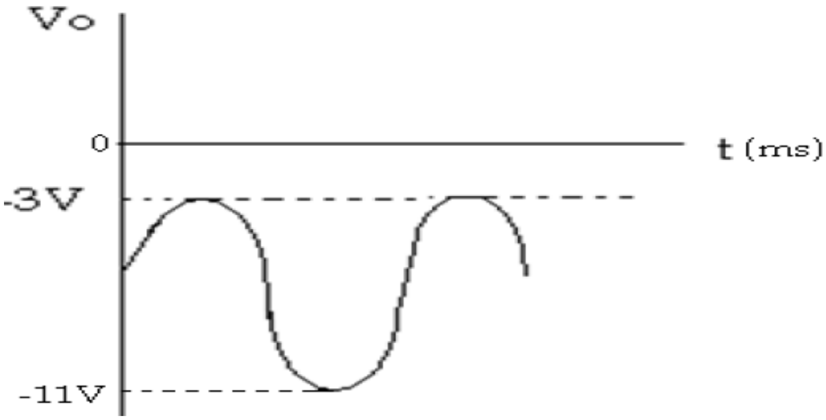


IV) **Design a Clamping Circuit to clamp Positive Peak at -3V:**

Circuit Diagram:



Waveforms:



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

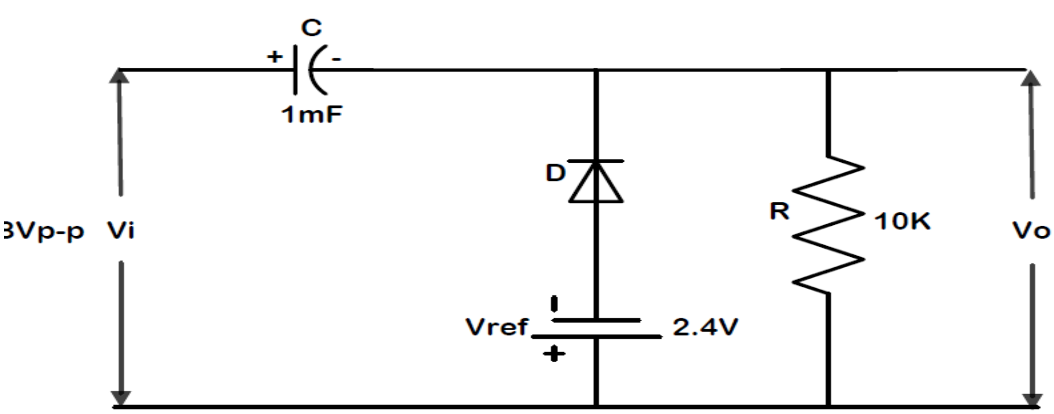
$$V_{ref} = | - V_o + V_\vartheta$$

= +3+0.7

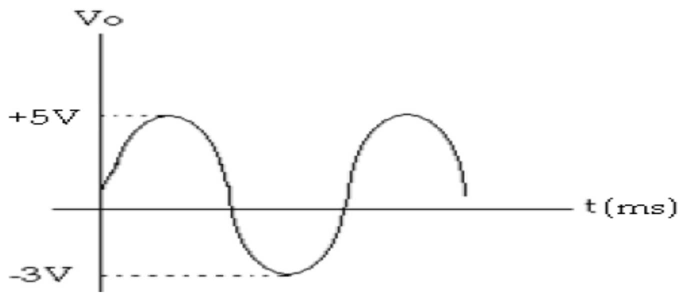
Vref = 3.7

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

Circuit Diagram:



Waveforms:



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

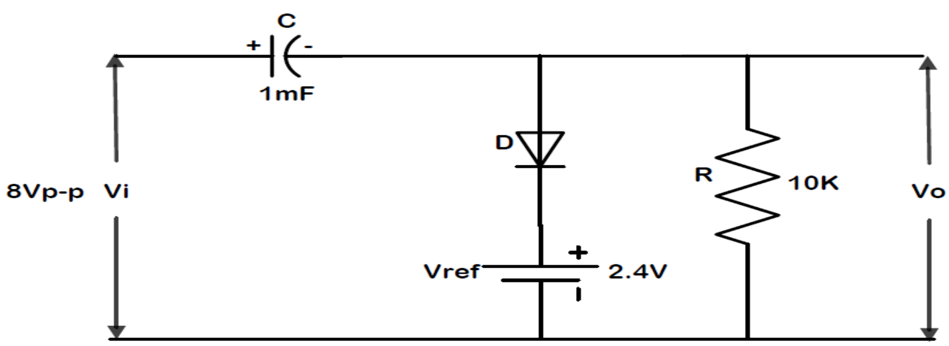
$$V_{ref} = -V_o - V_\vartheta$$

= - 0.7 – (- 3)

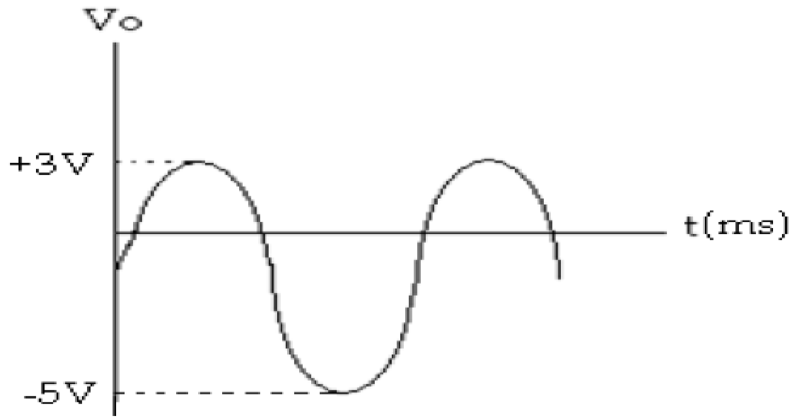
Vref =+2.3V

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 : 4

RECTIFIER CIRCUITS

Aim: To design and test Half wave, Full wave, Bridge Rectifier circuits with & without capacitor
filter and determine the Ripple factor, Regulation & Efficiency.

Components required:

- Resistors
- Diodes
- 12-0-12V Transformer
- Capacitor

Calculations:

Assume RL = 4.7KΩ, C = 220 µ f

I) Half wave Rectifier:

1. Ripple Factor without Filter (Theoretical) = 1.21

2. Percentage Regulation = $\frac{R_f}{R_L} \times 100$ (R_f = Diode forward resistance)

3. Rectifier Efficiency η = $\frac{0.406}{1+\frac{R_f}{R_L}} \simeq 40.6$ %

4. Ripple Factor without Filter $\Upsilon = \frac{1}{2\sqrt{3}\, f R_L C}$ (f = frequency = 50Hz)

II) Full wave Rectifier:

1. Ripple Factor without Filter = 0.48

2. Percentage Regulation = $\frac{R_f}{R_L} \times 100$

3. Rectifier Efficiency $\eta = \frac{0.81}{1+\frac{R_f}{R_L}}$ =81 %

4. Ripple Factor without Filter $\Upsilon = \frac{1}{4\sqrt{3}\, fCR_L}$

III) Bridge Rectifier:

1. Ripple Factor without Filter = 0.48

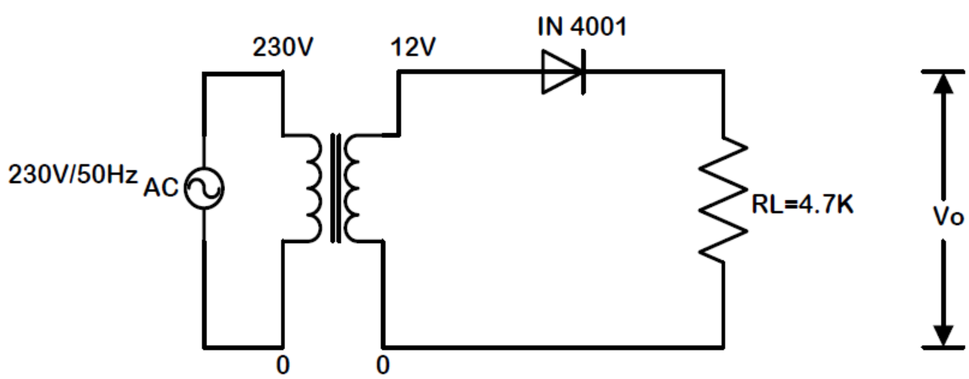
2. Percentage Regulation = $\frac{R_f}{R_L} \times 100$

3. Rectifier Efficiency $\eta = \frac{0.81}{1+\frac{R_f}{R_L}}$ =81 %

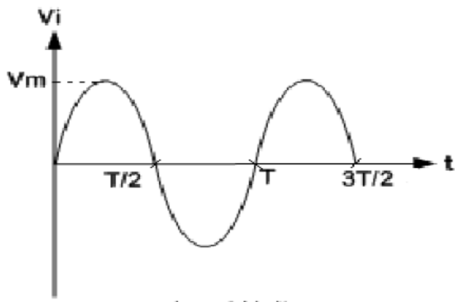
4. Ripple Factor without Filter $\Upsilon = \frac{1}{4\sqrt{3}\, fR_LC}$

I) Half wave Rectifier without Filter:

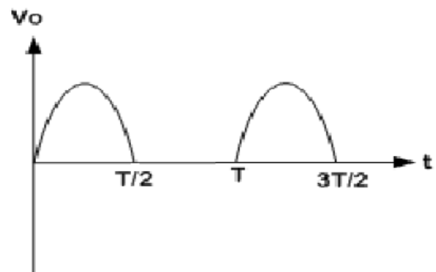
Circuit Diagram:



Waveforms:



Input Voltage



Output Voltage

Peak output voltage V_m=

$V_{dc} = \frac{Vm}{\pi} =$

$V_{rms} = \frac{Vm}{2} =$

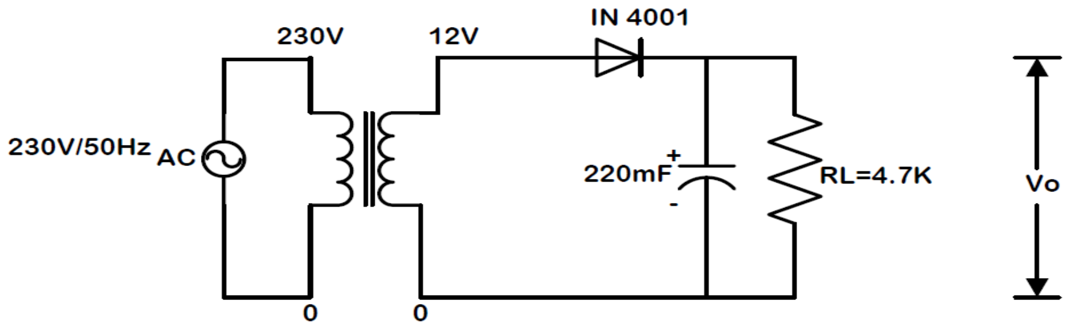
$V_{ac} = \sqrt{V_{rms^2}} - V_{dc^2} =$

Ripple Factor $Y = \frac{V_{ac}}{V_{dc}} =$

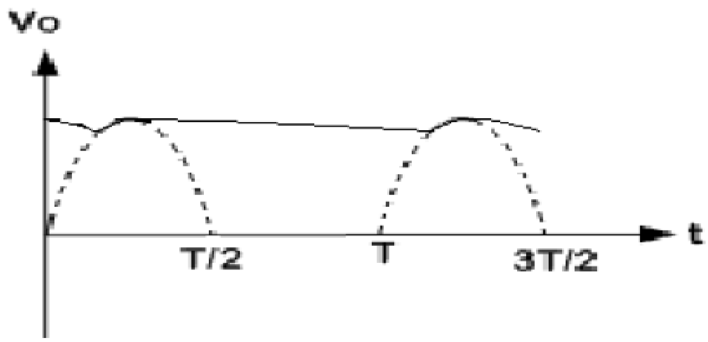
Rectifier efficiency $\eta = \frac{P_{dc}}{P_{ac}} = \frac{V_{dc^2}}{V_{rms^2}} =$

% Regulation $= \frac{V_{dc(NL)} - V_{dc\,(FL)}}{V_{dc\,(FL)}} \times 100 =$

II) Half wave Rectifier with Filter:



Waveforms:



Peak output Voltage $V_m =$

Ripple Factor $= \frac{V_{ac}}{V_{dc}} =$

$V_{dc} = \frac{V_m}{1+\frac{1}{2fR_LC}} =$

$V_{ac} = \frac{V_{rp-p}}{2} =$

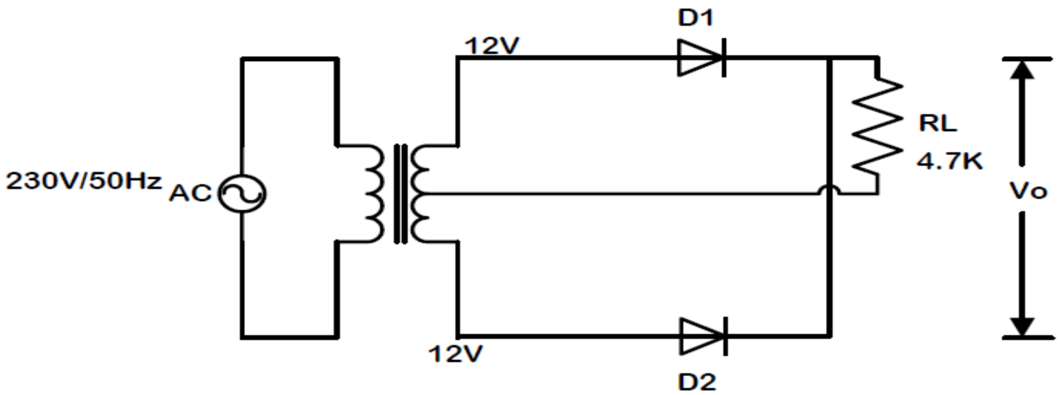
$V_{rms} = \sqrt{V_{dc}^2 + V_{ac}^2} =$

Rectifier efficiency $\eta = \frac{P_{dc}}{P_{ac}} = \left[\frac{V_{dc}}{V_{rms}}\right]2 =$

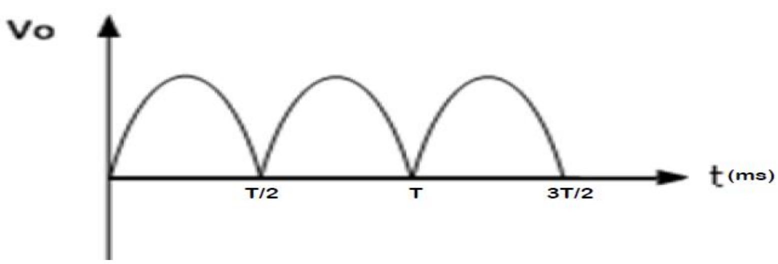
% Regulation $= \frac{V_{dc(NL)} - V_{dc\,(FL)}}{V_{dc\,(FL)}} \times 100 =$

III) Full wave Rectifier without Filter:

Circuit Diagram:



Waveforms:



$$V_{dc} = \frac{2Vm}{\pi} =$$

$$V_{rms} = \frac{Vm}{\sqrt{2}} =$$

$$V_{ac} = \sqrt{V_{rms}^2 - V_{dc}^2} =$$

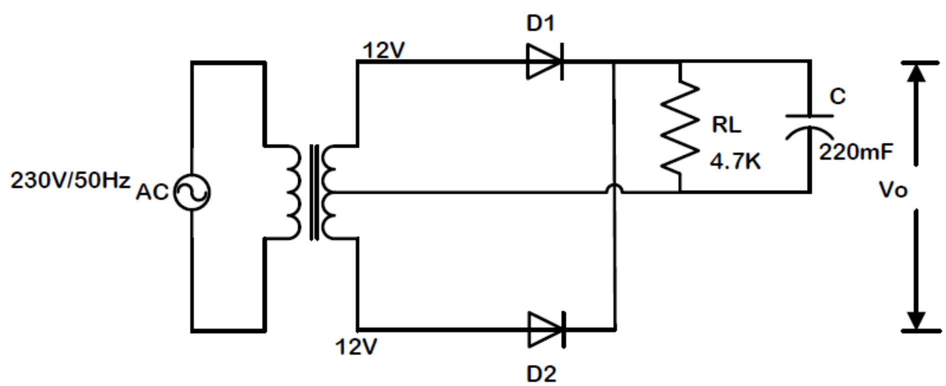
$$\Upsilon = \frac{V_{ac}}{V_{dc}} =$$

$$\eta = \frac{P_{dc}}{P_{ac}} = \left[\frac{V_{dc}}{V_{rms}}\right]2 =$$

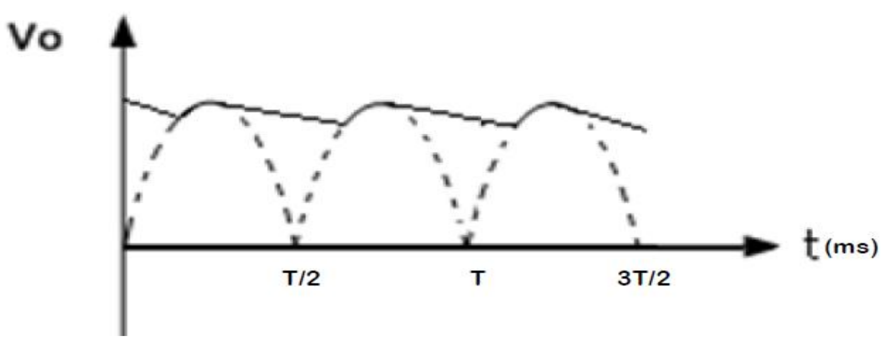
$$\% \text{ Regulation} = \frac{V_{dc(NL)} - V_{dc\,(FL)}}{V_{dc\,(FL)}} \times 100 =$$

IV) Full wave Rectifier with Filter:

Circuit Diagram:



Waveforms:



$$V_{dc} = \frac{V_m}{1 + \frac{1}{4fR_LC}} =$$

$$V_{ac} = \frac{V_{r-(p-p)}}{2\sqrt{3}} =$$

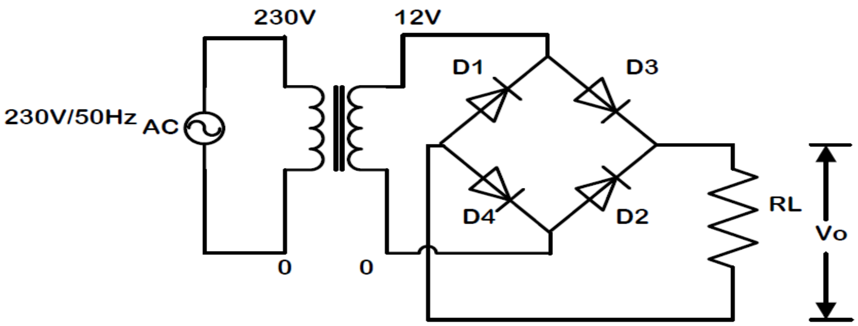
$$\Upsilon = \frac{V_{ac}}{V_{dc}} =$$

$$V_{rms} = \sqrt{V_{dc}{}^2 + V_{ac}{}^2} =$$

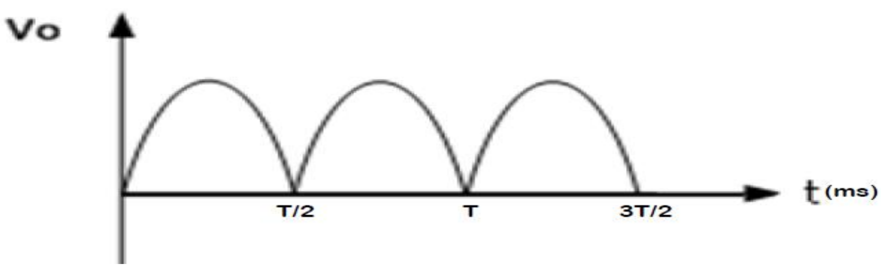
$$\eta = \frac{P_{dc}}{P_{ac}} = \left[\frac{V_{dc}}{V_{rms}}\right]2 =$$

V) Bridge Rectifier without Filter:

Circuit Diagram:



Waveforms:



$$V_{dc} = \frac{2Vm}{\pi} =$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} =$$

$$V_{ac} = \sqrt{V_{rms}{}^2 - V_{dc}{}^2} =$$

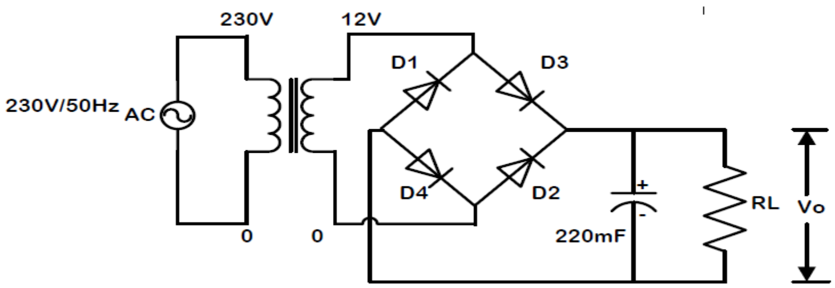
$$\Upsilon = \frac{V_{ac}}{V_{dc}} =$$

$$\eta = \frac{P_{dc}}{P_{ac}} = \left[\frac{V_{dc}}{V_{rms}}\right]2 =$$

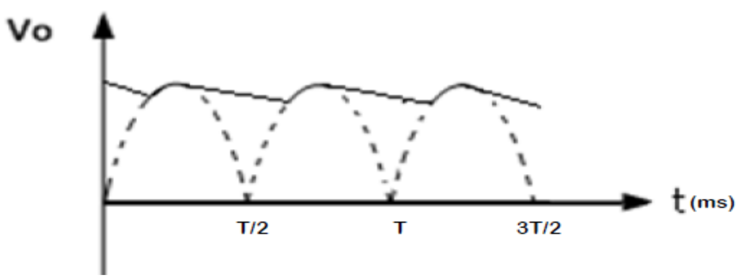
% Regulation = $\frac{V_{dc(NL)} - V_{dc(FL)}}{V_{dc(FL)}} \times 100 =$

VI) Bridge Rectifier with Filter:

Circuit Diagram:



Waveforms:



$V_{dc} = \frac{V_m}{1 + \frac{1}{4fR_LC}} =$

$V_{ac} = \frac{V_{r-(p-p)}}{2\sqrt{3}} =$

$\Upsilon = \frac{V_{ac}}{V_{dc}} =$

$V_{rms} = \sqrt{V_{dc}^2 + V_{ac}^2} =$

$\eta = \frac{P_{dc}}{P_{ac}} = \left[\frac{V_{dc}}{V_{rms}}\right]2 =$

Procedure:

- Make the Connections as shown in the circuit diagram
- Apply 230V AC supply from the power mains to the primary of the transformer
- Observe the voltage across secondary to get Vm , the peak value in CRO
- Use relevant formula to find Vdc and Vrms of both Full wave and Half wave rectifier & draw the waveforms
- Find out the Ripple factor, Regulation and Efficiency by using the formula.

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

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

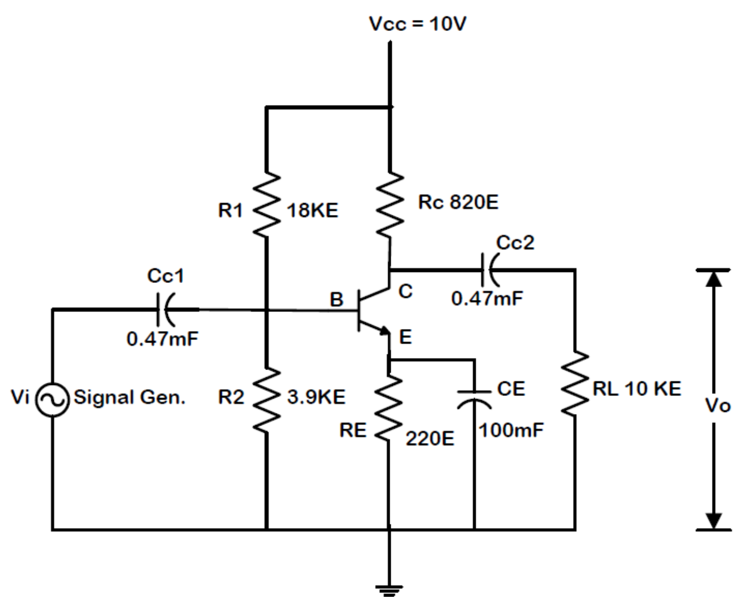
Select C_E as $100\mu F$

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

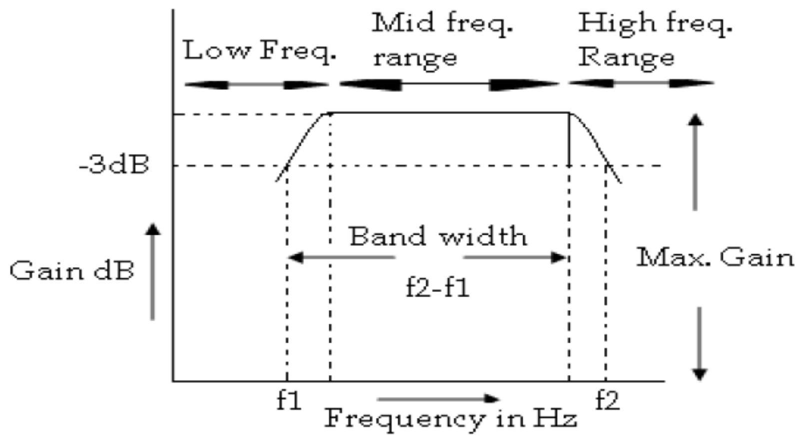
Procedure:

- 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:

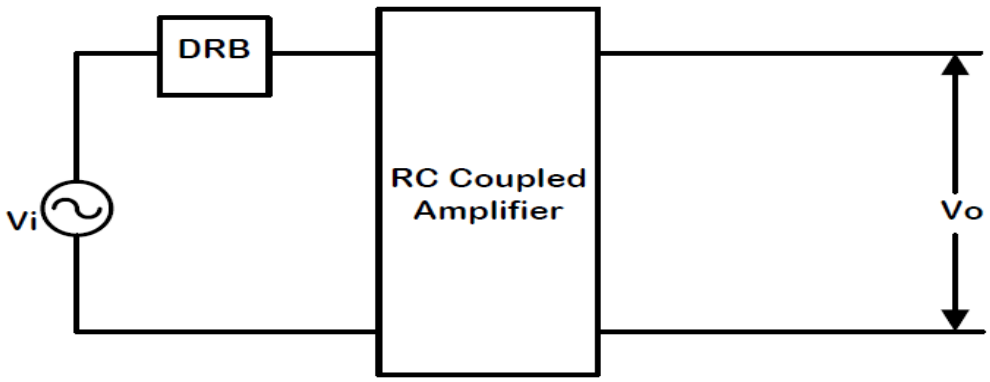
Freq. in Hz	$V_{o\ P\text{-}P}$	$A_V = V_o/V_1$	Gain in dB = 20 $\log_{10} A_V$
50 Hz 100 Hz 200 Hz 300 Hz 500 Hz 1KHz			

To measure input impedance and output impedance:

I) Input impedance (Ri):

Procedure:

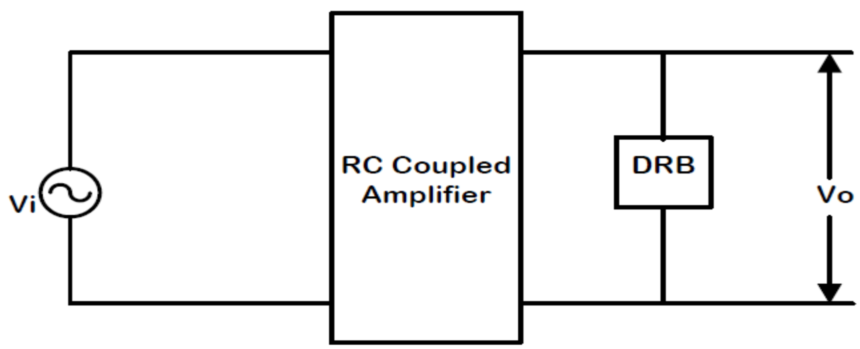
- Connect the circuit as shown
- Set the DRB to a minimum value
- Set the output to a convenient level and note down the output voltage
- Increase the DRB value till VO becomes half of the maximum amplitude
- The corresponding DRB value gives input impedance



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

JFET AMPLIFIER (COMMON SOURCE)

AIM: To study the frequency response of a Common Source Field Effect Transistor and to find the Bandwidth from the Response.

APPARATUS:

S.No	Name	Range / Value	Quantity
1	Regulated D.C Power supply	0–30 Volts	1
2	JFET	BFW10 or 11	1
3	Signal Generator	(0 – 1MHz)	1
4	Resistors	1KΩ, 2.2MΩ, 4.7KΩ, 470Ω	Each 1
5	Capacitors	47μf	2
6	Capacitors	0.001μf	1
7	Bread Board and connecting wires	-	1 Set
8	Dual Trace CRO	20MHz	1 No

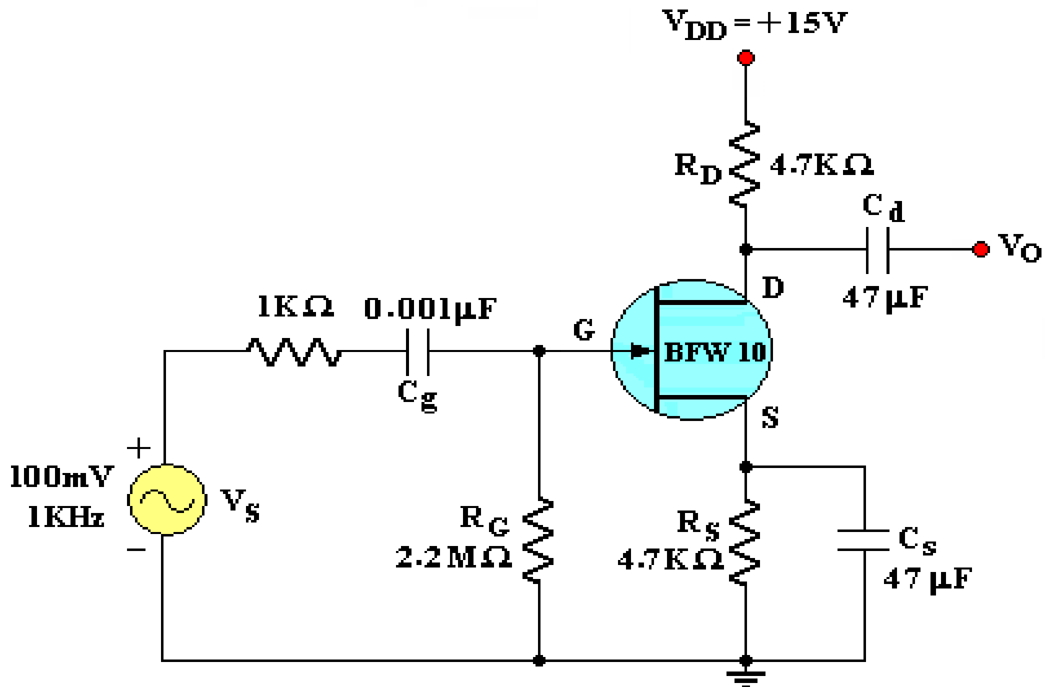
PROCEDURE:

1. Connect the circuit as per the Fig.
2. Keep I/P Voltage at 100mV.
3. Vary the frequency from 50 Hz to 1MHz in appropriate steps and note down the corresponding source voltage Vs and o/p Voltage Vo in a tabular Form .
4. Plot the frequency (f) Vs Gain (Av) on a semi-log graph sheet and determine the Bandwidth. From the graph.

PRECAUTIONS:

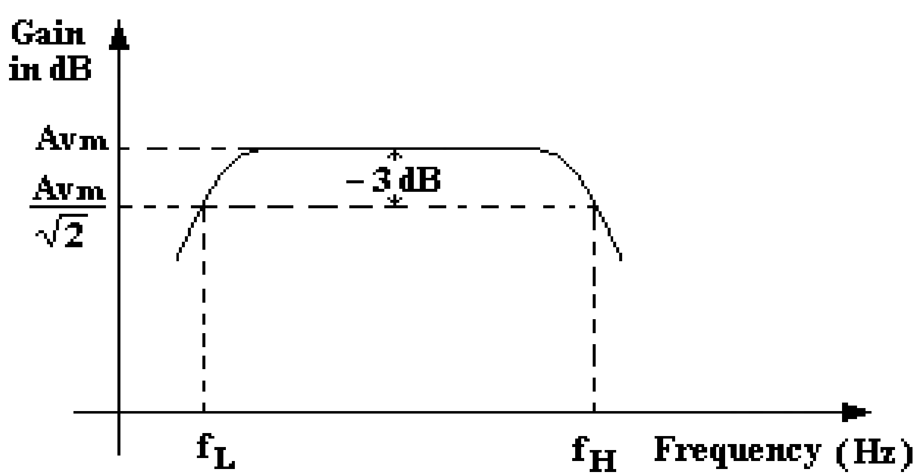
1. Check the wires for continuity before use.
2. Keep the power supply at Zero volts before Start
3. All the contacts must be intact
4. For a good JFET ID will be □□11.0 mA at VGS = 0.0 Volts if not change the JFET

CIRCUIT DIAGRAMS:



Common Source JFET Amplifier

MODEL GRAPH:



TABULAR FORMS:

I/P Voltage, V_s = 100mV

S.No	Frequency (Hz)	O/P Voltage, Vo (V)	Voltage Gain Av =Vo/Vi	Av in dB = 20 log (Av)
1	50			
2	100			
3	200			
4	300			
5	500			
6	700			
7	1K			
8	3K			
9	5K			
10	7K			
11	10K			
12	30K			
13	50K			
14	70K			
15	100K			
16	300K			
17	500K			
18	700K			
19	1M			

RESULT:

BandWidth , B.W = f2 – f1 = Hz

EXPERIMENT NO : 7

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)

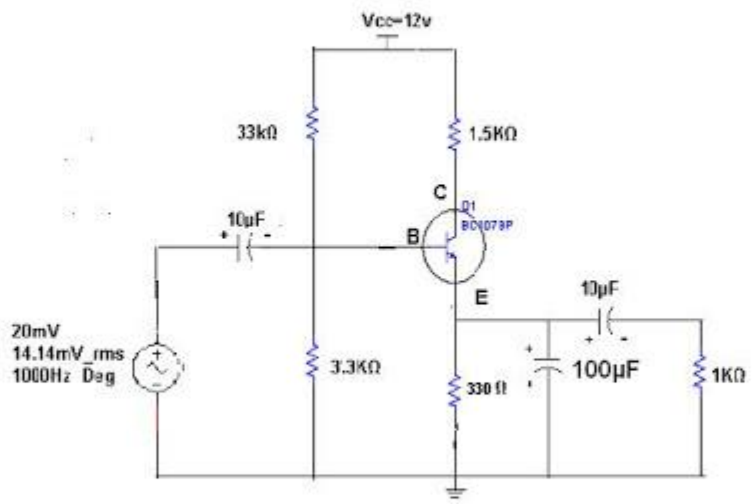
Function Generator

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:

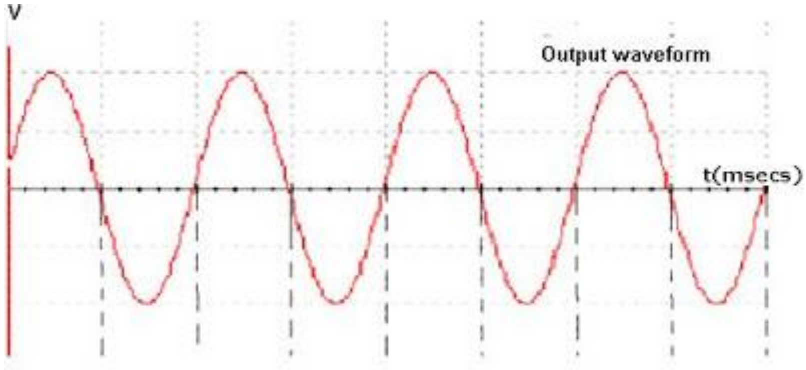
Voltage Gain:

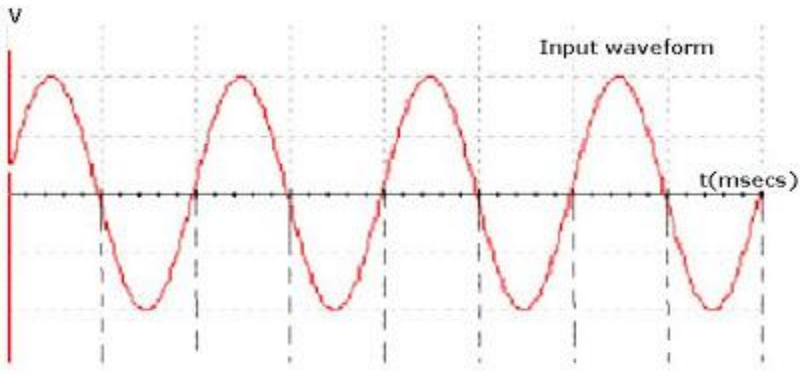
S.NO	Output Voltage (V_o) with feedback	Output Voltage (V_o) without feedback	Gain(dB) with feedback	Gain(dB) without feedback

Frequency Response: $V_i = 20mV$

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

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 : 8

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 ϑ = 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 ϑ = 20Hz

Choose $C_C = 47\ \mu F$

Design of ϑ Selective Circuit:

Required ϑ of oscillations f = 1KHz

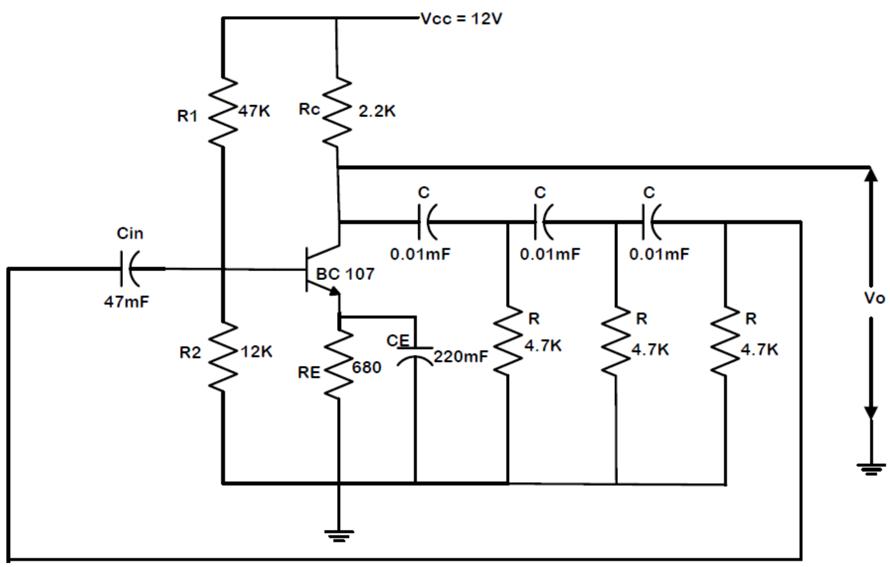
$$f = \frac{1}{2\pi R_{C\sqrt{6}+\frac{4R_C}{R}}}$$

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 : 9

CHARACTERISTICS OF VOLTAGE REGULATORS

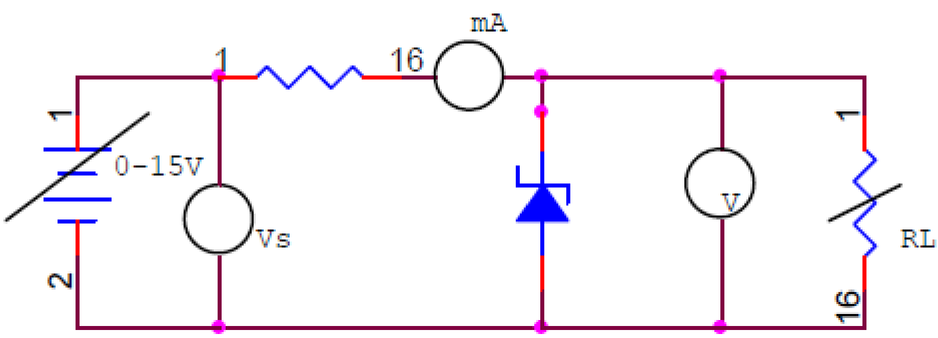
A) SIMPLE ZENER VOLTAGE REGULATORS

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.

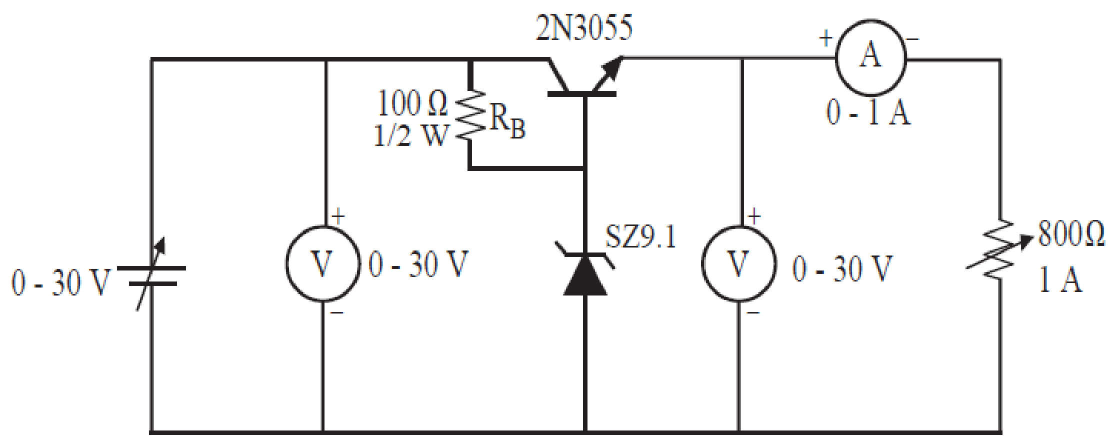
These defects are rectified in a zener regulator with emitter follower output. It is a circuit that combines a zener regulator and an emitter follower. The dc output voltage of the emitter follower is V_o = VZ - VBE. When input voltage changes, zener voltage remains the same and so does the output voltage.

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

EXPERIMENT NO : 10

ASTABLE AND MONOSTABLE MULTIVIBRATOR USING IC 555

AIM: To design and study the following circuits using 555 timer.

1. MONOSTABLE MULTIVIBRATOR

2. ASTABLE MULTIVIBRATOR

APPARATUS REQUIRED:

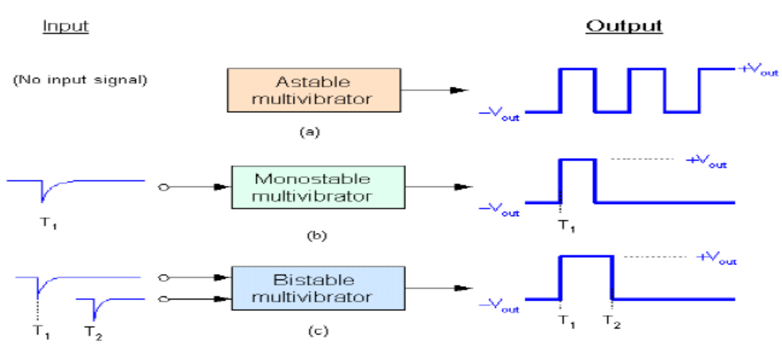
IC 555, Resistors , capacitors, CRO, Function generator, RPS

THEORY:

555 is a very commonly used IC for generating accurate timing pulses. It is an 8pin timer IC.The 555 has three operating modes:

- Monostable mode
- Astable – free running mode
- Bistable mode or Schmitt trigger

The input/output relationships for the various multivibrators are shown in Figure



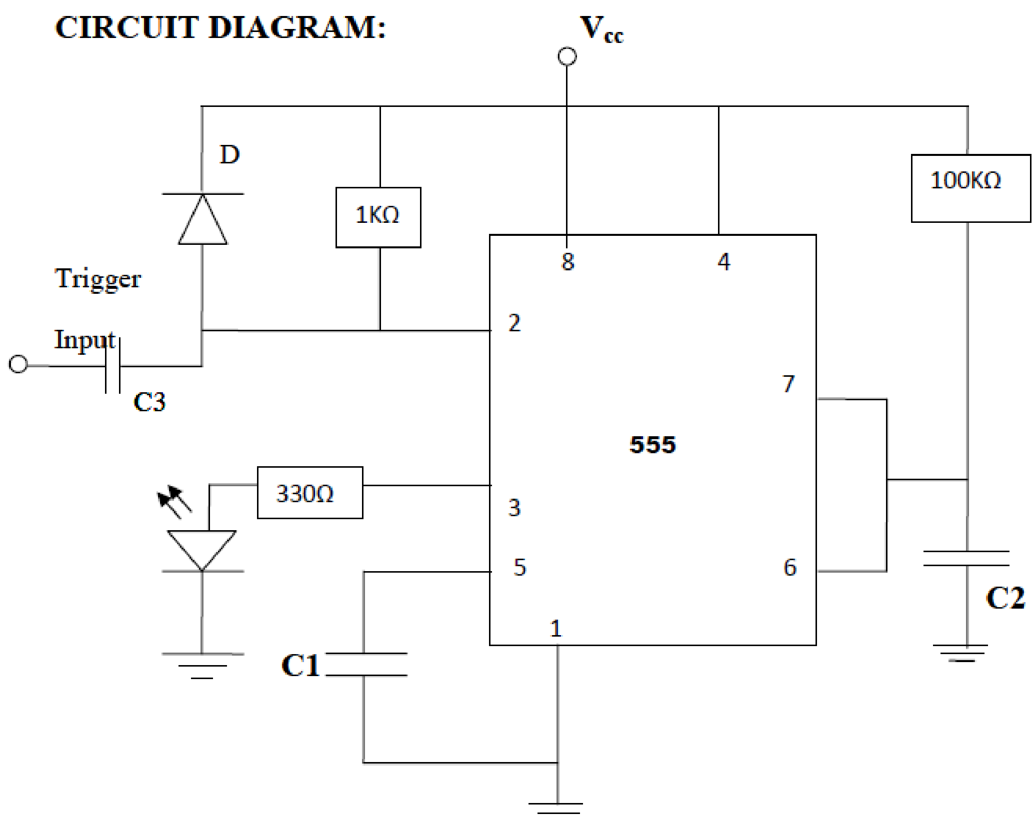
MONOSTABLE MULTIVIBRATOR

Monostable multivibrator often called a one shot multivibrator is a pulse generating circuit in which the duration of this pulse is determined by the RC network connected externally to the 555 timer. In a stable or standby state, the output of the circuit is approximately zero or a logic-low level. When external trigger pulse is applied output is forced to go high (□ V_{CC}). The time for which output remains high is determined by the external RC network connected to the timer. At the end of the timing interval, the output automatically reverts back to its logic-low stable state. The output stays low until trigger pulse is again applied. Then the cycle repeats. The monostable circuit has only one stable state (output low) hence the name *monostable.*

DESIGN OF MONOSTABLE MULTIVIBRATOR

Time period of pulse=T=1.1RC=10ms
Let C=100f
T=1.1RC
10ms=1.1*R*100f
R=100K

CIRCUIT DIAGRAM:

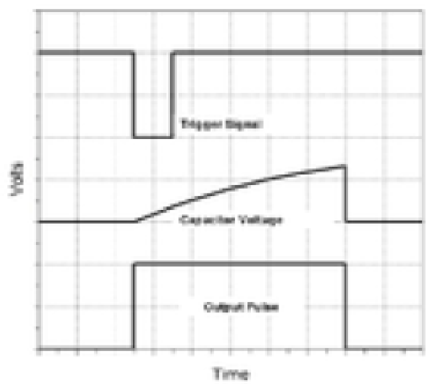


C1 = .01µf, C2 = 100µf, C3 = .001µf

TABULATION:

INPUT		OUTPUT	
AMPLITUDE	TIME PERIOD	AMPLITUDE	TIME PERIOD

MODEL GRAPH:



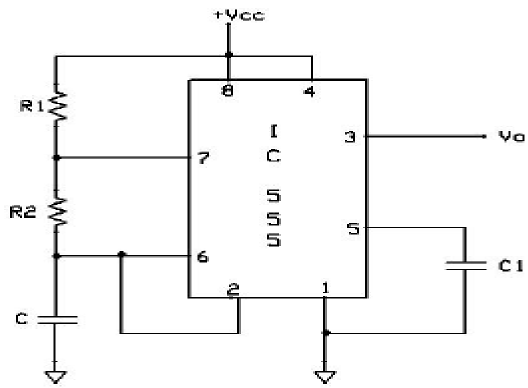
PROCEDURE:

1.Connections are made as per the circuit diagram
2.A trigger pulse is given to pin No 2
3.Note the time for which the LED glows and note down Ton

ASTABLE MULTIVIBRATOR

The astable multivibrator generates a square wave, the period of which is determined by the circuit external to IC 555. The astable multivibrator does not require any external trigger to change the state of the output. Hence the name free running oscillator. The time during which the output is either high or low is determined by the two resistors and a capacitor which are externally connected to the 555 timer.

CIRCUIT DIAGRAM:



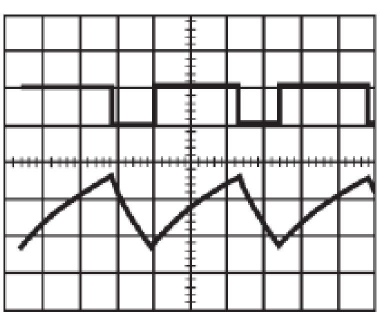
VALUES: R1=10KΩ, R2=100KΩ, C=0.1µf, C1=0.01µf

TABULATION:

INPUT			OUTPUT		
AMPLITUDE	TIME PERIOD		AMPLITUDE	TIME PERIOD	
	ON time	OFF time		Charging time	Discharging time

MODEL GRAPH:

OUTPUT VOLTAGE AND CAPACITOR VOLTAGE



RESULT: