TE0221

ANALOG AND DIGITAL SYSTEM LAB

Laboratory Manual

DEPARTMENT OF TELECOMMUNICATION ENGINEERING

SRM UNIVERSITY

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DEPARTMENT OF TELECOMMUNICATION ENGINEERING

TE0221

ANALOG AND DIGITAL SYSTEM LAB

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SRM UNIVERSITY

Department of Telecommunication Engineering

TEO221 ANALOG AND DIGITAL SYSTEM LAB

List of Analog Experiments

S. No	Name of the experiment
1	Inverting and Non inverting Amplifier
2	Summing and Differential Amplifier
3	Linear Op amp circuits such as Instrumentation amplifier, Integrator and Differentiator
4	Precision Rectifier
5	Comparator
6	RC Phase Shift Oscillator and Wein Bridge Oscillator
7	Applications of Timer IC 555
8	Study of Timer IC 555
9	Study of Function Generator IC566

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List of Digital Experiments

S.No	Name of the experiment
1	Study of Logic Gates
2	Study of Flip Flops using Gates
3	Multiplexers and Demultiplexers
4	Encoders and Decoders
5	Implementation of Combinational and Arithmetic Functions using Mux,Demux and Decoders
6	Design of Synchronous Circuit
7	Ripple Counters
8	Shift Registers

INVERTING AND NON-INVERTING AMPLIFIERS

Pre-Lab questions:

1. What is an Op-amp?
2. Design an inverting amplifier with a gain of -10 and input resistance equal to 10KΩ.
3. Design a Non-inverting amplifier with a gain of +5 using one Op-amp
4. What are the different linear IC packages?
5. List the characteristics of an ideal Op-amp.

EXPT NO:1

DATE:

INVERTING AND NON-INVERTING AMPLIFIERS

AIM:

To study the following linear applications of op-amp

1. Inverting amplifier
2. Non – inverting amplifier

APPARATUS REQUIRED:

1. Op – Amp IC 741
2. Dual Power Supply 15V,
3. Resistors
4. Capacitors
5. Function Generator
6. Cathode Ray Oscilloscope
7. Multimeter
8. Breadboard and Connecting Wires

THEORY:

Inverting Amplifier:

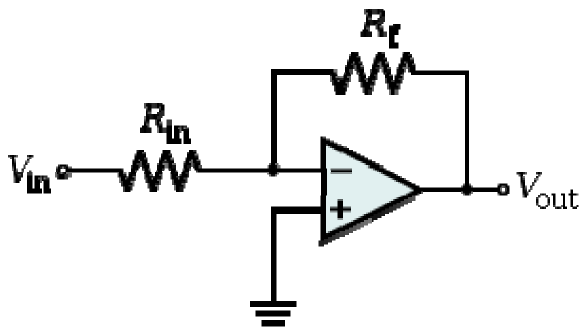
This is the most widely used of all the Op-amp circuits. The output V_0 is fed back to the inverting input through the R_f – R_{in} network as shown in figure where R_f is the feedback resistor. The input signal V_i is applied to the inverting input terminal through R_{in} and non-inverting input terminal of Op-amp is grounded.The output V_0 is given by

$$V_0 = V_i\,(-R_f / R_{in})$$

Where, the gain of amplifier is $- R_f / R_{in}$

The negative sign indicates a phase-shift of 180 degrees between V_i and V_0. The effective input impedance is R_i. An inverting amplifier uses negative feedback to invert and amplify a voltage. The R_{in},R_f resistor network allows some of the output signal to be returned to the input. Since the output is 180° out of phase, this amount is effectively subtracted from the input, thereby reducing the input into the operational amplifier. This reduces the overall gain of the amplifier and is dubbed negative feedback

CIRCUIT DIAGRAM:



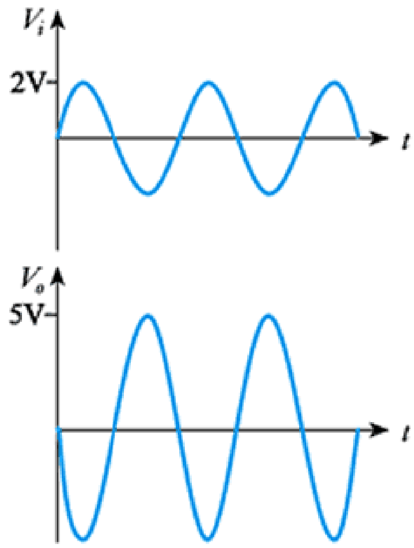
TABULATION:

V_i =---------------

R_{in} =---------------

S.No	R_f	**Observed** V_0	**Calculated** V_0 $V_0 = V_i\ (-R_f / R_{in})$

MODEL GRAPH:



Non – inverting amplifier

The circuit diagram of non – inverting amplifer is shown in figure. Here, the signal is applied to the non – inverting input terminal and feedback is given to inverting terminal. The circuit amplifiers the input signal without inverting it. The output V_{out} is given by

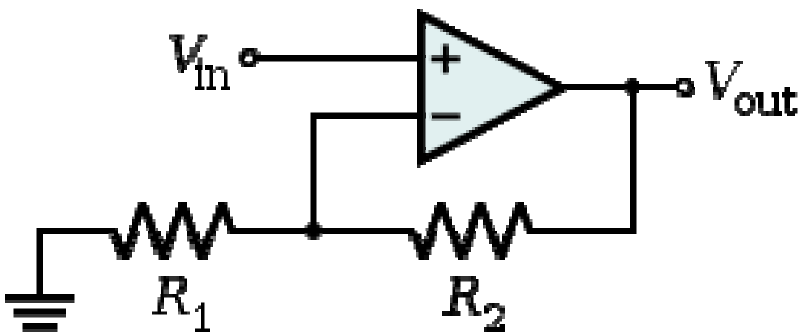
$$V_{out} = V_{in}\left(1 + \frac{R_2}{R_1}\right)$$

The voltage gain is given by

$$A_{CL} = \frac{V_{0ut}}{Vin} = \left[1 + \frac{R_2}{R_1}\right]$$

Compared to the inverting amplifier, the input resistance of the non-inverting is extremely large.

CIRCUIT DIAGRAM:

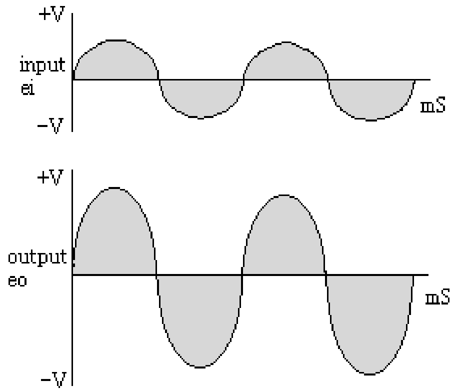


TABULATION: V_i =---------------

R_{in} =---------------

S.No	R_f	**Observed** V_0	**Calculated** V_0 $V_0 = V_i\,(-R_f / R_{in})$

MODEL GRAPH:



PROCEDURE:

Inverting & Non – inverting amplifier

1. Make connections as given in fig 1 & fig 2 for inverting and non inverting amplifiers respectively.
2. Give sinewave input of V_i volts using AFO with the frequency of 1 KHZ.
3. The output voltage V_0 observed on a CRO. A dual channel CRO to be used to see V_i & $V_{o.}$
4. Vary R_f and measure the corresponding V_0 and observe the phase of V_0 with respect to $V_{0.}$
5. Tabulate the readings and verify with theoretical values.

RESULT:

Thus the linear applications of 741 op amp were studied experimentally.

Post Lab Questions:

1. What is the input impedance of a non inverting op-amp amplifier?

2. If the open loop gain of an op-amp is very large, does the closed loop gain depend upon the external components or the op-amp?

3. Define common mode rejection ratio

4. Explain the meaning of open loop and closed loop operation of an op- amp?

5. What is a practical op-amp? Draw its equivalent circuit.

SUMMING AND DIFFERENTIAL AMPLIFIER

Pre-Lab questions:

1. What is a Differential amplifier
2. Define a Summing amplifier
3. Define difference mode gain and common mode gain
4. Give the applications of summing and differential amplifier

EXPT NO:2

DATE:

SUMMING AND DIFFERENTIAL AMPLIFIER

AIM:

To study the operation of IC741 as

a) Summing Amplifier
b) Differential Amplifier

APPARATUS REQUIRED:

1. Op-Amp IC 741
2. Dual power Supply 15V
3. Resistor
4. Capacitors
5. Function Generator
6. Cathode Ray Oscilloscope
7. Multimeter
8. Breadboard and Connecting wires.

THEORY:

Summing Amplifier:

This is one of the liner applications of the Op-Amp. A circuit whose output is the sum of several input signals is called a summer. Shown in fig.1 is an inverting summer. The output is

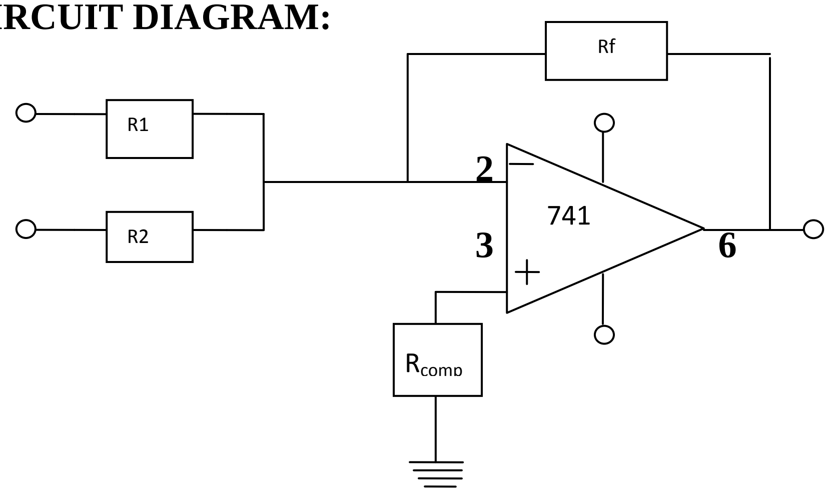
$$V_0 = -\left[\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2\right]$$

When $R_f = R_1 = R_2$, then

$$V_0 = -(V_1+V_2)$$

That is, the output is an inverted sum of the inputs.

CIRCUIT DIAGRAM:



R1, R2, Rf = 10kΩ R_{comp} = 5KΩ

TABULATION:

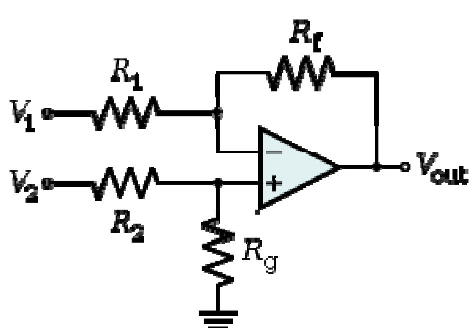
S.no	V_1	V_2	Observed output vo	Theoretical output $-(V_1+V_2)$

Differential amplifier:

A basic differential amplifier can be used as a subtractor. If all the resistor are equal in value as given in figure, then the output voltage can be derived by using superposition principle

$$V_{0ut} = (V_2 - V_1)$$

CIRCUIT DIAGRAM:



VALUES: R_f=10KΩ, R_1=10KΩ , R_2 =10KΩ,

TABULATION:

S.no	V_1	V_2	Observed output V_{0ut}	Theoretical output $V_{0ut} = (V_2 - V_1)$

PROCEDURE:

1. Connect the circuit as shown in the figures to construct summer and subtractor circuit respectively.
2. Vary the voltages in RPS and observe the output voltages.
3. Check the result with the theoretical values.

RESULT:

Thus the liner applications of 741 op amp were studied experimentally.

Post Lab Questions:

1. What is a current mirror?
2. What is cross over distortion and how it is eliminated?
3. For op-amp, CMRR=10^5 and differential gain A_{dm}=10^5. Calculate the common mode gain A_{cm} of the Op-amp
4. Why the gain of the differential amplifier is choosen to be a large one?

LINEAR OP AMP CIRCUITS SUCH AS INSTRUMENTATION AMPLIFIER, INTEGRATOR AND DIFFERENTIATOR

Pre-Lab questions:

1. What are the features of an instrumentation amplifier
2. What is an instrumentation amplifier? Draw a system whose gain is controlled by an adjustable resistance.
3. What is an integrator and a differentiator?
4. What are the limitations of an ordinary op-amp differentiator? Draw the circuit of a practical differentiator that will eliminate these limitations
5. Draw the circuit of a Lossy integrator showing initial conditions

EXPT NO:3

DATE:

LINEAR OP AMP CIRCUITS SUCH AS INSTRUMENTATION AMPLIFIER, INTEGRATOR AND DIFFERENTIATOR

AIM:

To verify the linear op amp circuit such as instrumentation amplifier, Integrator and differentiator.

APPARATUS REQUIRED:

1.Resistor

2.Capacitor

3.AFO

4.OpAmp

5.Dual Supply

6.CRO

7.Bread Board

THEORY:

An instrumentation (or instrumentational) amplifier is a type of differential amplifier that has been outfitted with input buffers, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment. Additional characteristics include very low DC offset, low drift, low noise, very high open-loop gain, very high common-mode rejection ratio, and very high input impedances. Instrumentation amplifiers are used where great accuracy and stability of the circuit both short- and long-term are required.

The most commonly used instrumentation amplifier circuit is shown in the figure. The gain of the circuit is

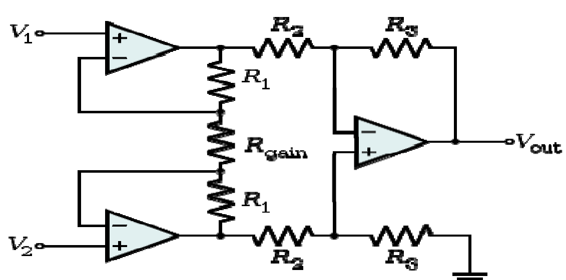
$$\frac{V_{\text{out}}}{V_2 - V_1} = \left(1 + \frac{2R_1}{R_{\text{gain}}}\right)\frac{R_3}{R_2}$$

The rightmost amplifier, along with the resistors labelled R_2 and R_3 is just the standard differential amplifier circuit, with gain = R_3 / R_2 and differential input resistance = $2 \cdot R_2$. The two amplifiers on the left are the buffers. With R_{gain} removed (open circuited), they are simple unity gain buffers; the circuit will work in that state, with gain simply equal to R_3 / R_2 and high input impedance because of the buffers. The buffer gain could be increased by putting resistors between the buffer inverting inputs and ground to shunt away some of the negative feedback; however, the single resistor R_{gain} between the two inverting inputs is a much more elegant method: it increases the differential-mode gain of the buffer pair while leaving the common-mode gain equal to 1. This increases the common-mode rejection ratio (CMRR) of the circuit and also enables the buffers to handle much larger common-mode signals without clipping than would be the case if they were separate and had the same gain.

Another benefit of the method is that it boosts the gain using a single resistor rather than a pair, thus avoiding a resistor-matching problem (although the two R_1s need to be matched), and very conveniently allowing the gain of the circuit to be changed by changing the value of a single resistor. A set of switch-selectable resistors or even a potentiometer can be used for R_{gain}, providing easy changes to the gain of the circuit, without the complexity of having to switch matched pairs of resistors.

The ideal common-mode gain of an instrumentation amplifier is zero. In the circuit shown, common-mode gain is caused by mismatches in the values of the equally-numbered resistors and by the mis-match in common mode gains of the two input op-amps. Obtaining very closely matched resistors is a significant difficulty in fabricating these circuits, as is optimizing the common mode performance of the input op-amps. An instrumentation amp can also be built with 2 op-amps to save on cost and increase CMRR, but the gain must be higher than 2 (+6 dB).

CIRCUIT DIAGRAM:



INTEGRATOR:

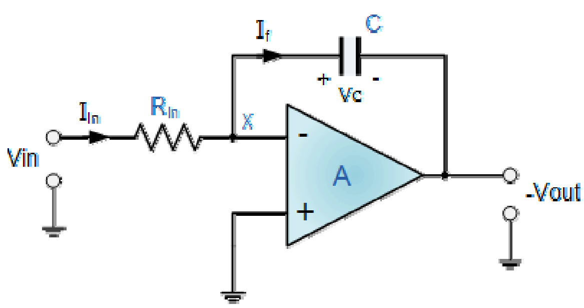
The Integrator Amplifier is an operational amplifier circuit that performs the mathematical operation of Integration, that is we can cause the output to respond to changes in the input voltage over time. The integrator amplifier acts like a storage element that "produces a voltage output which is proportional to the integral of its input voltage with respect to time". In other words the magnitude of the output signal is determined by the length of time a voltage is present at its input as the current through the feedback loop charges or discharges the capacitor as the required negative feedback occurs through the capacitor.

When a voltage, Vin is firstly applied to the input of an integrating amplifier, the uncharged capacitor C has very little resistance and acts a bit like a short circuit (voltage follower circuit) giving an overall gain of less than one. No current flows into the amplifiers input and point X is a virtual earth resulting in zero output. As the feedback capacitor C begins to charge up, its reactance Xc decreases this results in the ratio of Xc/Rin increasing producing an output voltage that continues to increase until the capacitor is fully charged.

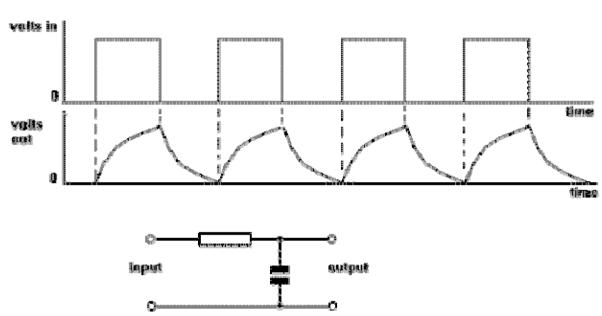
At this point the capacitor acts as an open circuit, blocking anymore flow of DC current. The ratio of feedback capacitor to input resistor (Xc/Rin) is now infinite resulting in infinite gain. The result of this high gain (similar to the op-amps open-loop gain), is that the output of the amplifier goes into saturation .Saturation occurs when the output voltage of the amplifier swings heavily to one voltage supply rail or the other with little or no control in between. The ideal voltage output for the Integrator Amplifier as:

$$V_{out} = -\frac{1}{R_{in}C}\int_0^t V_{in}\,dt = -\int_0^t V_{in}\frac{dt}{R_{in}.C}$$

CIRCUIT DIAGRAM:



WAVEFORMS:



DIFFERENTIATOR:

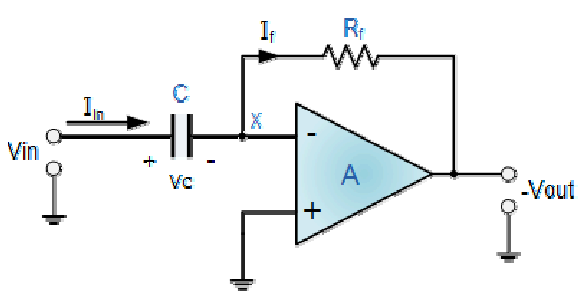
A Differentiator is a circuit that is designed such that the output of the circuit is proportional to the derivative of the input. It creates an output voltage proportional to the rate of change of the input voltage. This leads to cool applications such as extracting edges for, square waves, converting sine waves into cosines and c hanging triangle waves into square waves. But most circuits are susceptible to some trouble and this one's vulnerabilities are instability and noise. However, remedies are available to reduce the troubles without losing the desired function.

The input signal to the differentiator is applied to the capacitor. The capacitor blocks any DC content so there is no current flow to the amplifier summing point, X resulting in zero output voltage. The capacitor only allows AC type input voltage changes to pass through and whose frequency is dependant on the rate of change of the input signal. At low frequencies the reactance of the capacitor is "High" resulting in a low gain (Rf/Xc) and low output voltage from the op-amp. At higher frequencies the reactance of the capacitor is much lower resulting in a higher gain and higher output voltage from the differentiator amplifier.

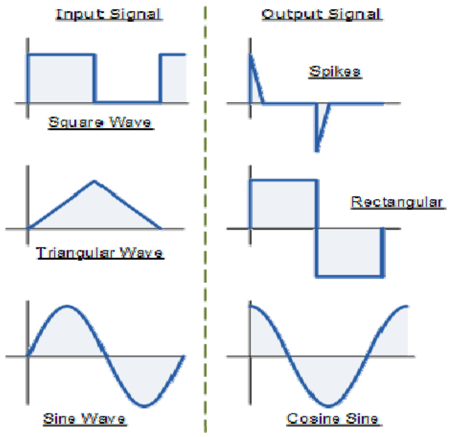
However, at high frequencies a differentiator circuit becomes unstable and will start to oscillate. This is due mainly to the first-order effect, which determines the frequency response of the op-amp circuit causing a second-order response which, at high frequencies gives an output voltage far higher than what would be expected. To avoid this the high frequency gain of the circuit needs to be reduced by adding an additional small value capacitor across the feedback resistor Rf. Ideal voltage output for the Differentiator Amplifier is given as:

$$V_{OUT} = -R_F C \frac{dV_{IN}}{dt}$$

CIRCUIT DIAGRAM:



WAVEFORMS:



PROCEDURE:

1. Connect the circuit as shown in the figures.
2. Set the input voltage using AFO.
3. Observe the output waveform in CRO and measure the output parameters.

RESULT:

Thus the linear Op Amp circuit such as Instrumentation amplifier,Integrator and Differentiator was designed and verified.

Post Lab Questions:

1. Explain why integrators are preferred over differentiators in analog computer
2. What are the applications of integrator and differentiator
3. Give the Practical applications of instrumentation amplifier
4. What are the monolithic instrumentation amplifier commercially available
5. What is the function of an instrumentation amplifier?

PRECISION RECTIFIER

Pre-Lab questions:

1. What is a precision diode
2. Give the uses of precision diode
3. Give some applications of precision diode
4. What are the major limitations of an ordinary diode
5. Define a half wave rectifier and a full wave rectifier

EXPT NO:4

DATE:

PRECISION RECTIFIER

AIM:

To construct precision half wave rectifier and full wave rectifier using Op Amp.

APPARATUS REQUIRED:

1.Resistor

2.IC 741

3.AFO

4.Diode IN 4001

5.Connecting wires

6.CRO

7.Bread board

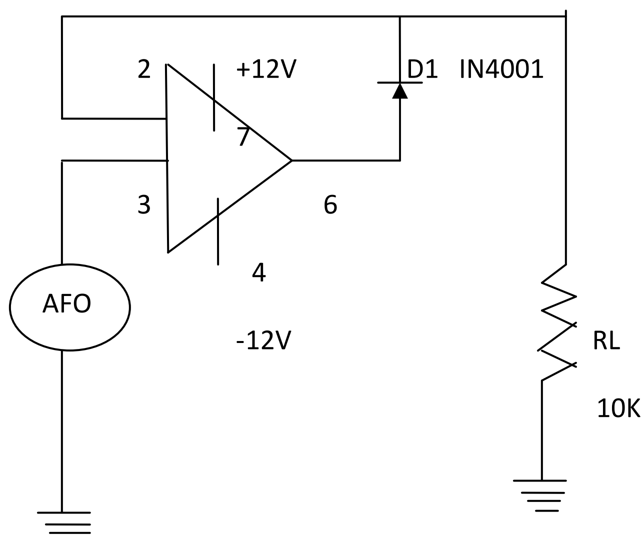
THEORY:

The major limitation of ordinary diodes is that it cannot rectify voltage below 0.6v,the cutin voltage of the diode.The precision rectifier, which is also known as a super diode, is a configuration obtained with an operational amplifier in order to have a circuit behaving like an ideal diode and rectifier.It can be useful for high-precision signal processing.

HALF WAVE RECTIFIER:

A half-wave rectifier is an electronic circuit. The rectifier circuit takes alternating current (AC) from the wall outlet and converts it into a positive direct current (DC) output. The particular electronic device that accomplishes this task is a semiconductor called a diode. The diode like all semiconductors is a material which has a resistance in between that of a conductor or wire and an insulator like that of a plastic.

CIRCUIT DIAGRAM:

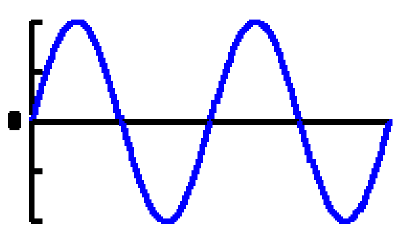


TABULATION:

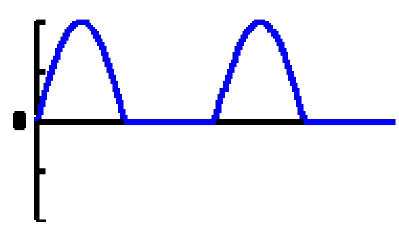
<table>
<tr><td colspan="2">INPUT</td><td colspan="3">OUTPUT</td><td>FREQUENCY</td></tr>
<tr><td rowspan="2">Amplitude</td><td rowspan="2">Time</td><td rowspan="2">Amplitude</td><td colspan="2">Time</td><td rowspan="3"></td></tr>
<tr><td>ON</td><td>OFF</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

MODEL GRAPH:

Input waveform:



Output waveform:

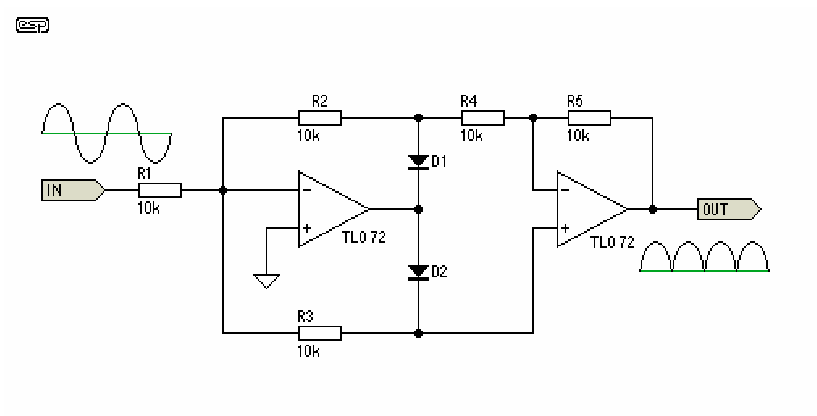


FULL WAVE RECTIFIER:

A Full Wave Rectifier is a circuit, which converts an ac voltage into a pulsating dc voltage using both half cycles of the applied ac voltage. It uses two diodes of which one conducts during one half cycle while the other conducts during the other half cycle of the applied ac voltage.

During the positive half cycle of the input voltage, diode D1 becomes forward biased and D2 becomes reverse biased. Hence D1 conducts and D2 remains OFF. The load current flows through D1 and the voltage drop across R_L will be equal to the input voltage. During the negative half cycle of the input voltage, diode D1 becomes reverse biased and D2 becomes forward biased. Hence D1 remains OFF and D2 conducts. The load current flows through D2 and the voltage drop across R_L will be equal to the input voltage.

CIRCUIT DIAGRAM:

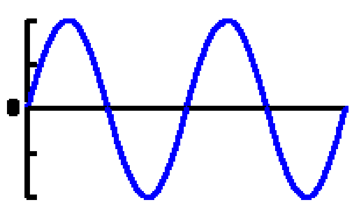


TABULATION:

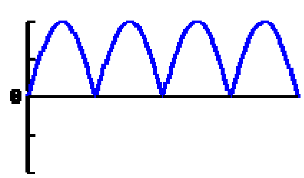
INPUT		OUTPUT			FREQUENCY
Amplitude	Time	Amplitude	Time		
			ON	OFF	

MODEL GRAPH:

Input waveform:



Output waveform:



PROCEDURE:

1. Connect the circuit as shown in the figures for Half wave and Full wave rectifier.
2. Set the input signal voltage using AFO.
3. Observe the output waveform in CRO and measure the output parameters.

RESULT:

Thus the half wave rectifier and full wave rectifier are constructed and the output waveforms are drawn.

Post Lab Questions:

1. Draw the circuit of a full wave rectifier and explain how it gives the average value
2. What is a Clipper and Clamper circuit
3. Draw the circuit of a clipper which will clip the input signal below a reference voltage
4. Draw the equivalent circuit of a full wave rectifier for input voltage less than zero volts($V_i<0$)

COMPARATOR

Pre-Lab questions:

1. What is a comparator circuit?
2. List the different types of comparator
3. Give the applications of comparator
4. Give the applications of Non linear op amp circuits

EXPT NO:5

DATE:

COMPARATOR

AIM:

To verify the Non linear op amp circuit comparator and its applications

APPARATUS REQUIRED:

1.Resistor

2.Capacitor

3.AFO

4.OP Amp

5.Dual supply

6.CRO

7.Bread board

THEORY:

A comparator is a device that compares two voltages or currents and switches its output to indicate which is larger. They are commonly used in devices such as Analog-to-digital converters (ADCs). A dedicated voltage comparator will generally be faster than a general-purpose operational amplifier pressed into service as a comparator. A dedicated voltage comparator may also contain additional features such as an accurate, internal voltage reference, an adjustable hysteresis and a clock gated input. A comparator normally changes its output state when the voltage between its inputs crosses through approximately zero volts. Small voltage fluctuations due to noise, always present on the inputs, can cause undesirable rapid changes between the two output states when the input voltage difference is near zero volts. To prevent this output oscillation, a small hysteresis of a few millivolts is integrated into many modern comparators

APPLICATION:

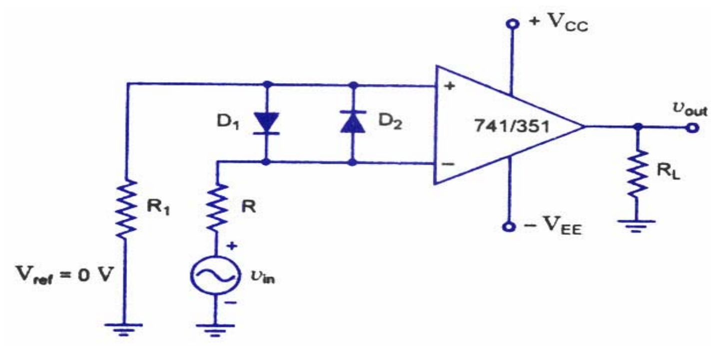
ZERO CROSSING DETECTOR:

For this type of detector, a comparator detects each time an ac pulse changes polarity. The output of the comparator changes state each time the pulse changes its polarity, that is, the output is HI (high) for a positive pulse and LO (low) for a negative pulse. The comparator also amplifies and squares the input signal

Zero-crossing detector is an applied form of comparator. Either of the op-amp basic comparator circuits discussed can be employed as the zero-crossing detector provided the reference voltage V_{ref} is made zero. Zero-crossing detector using inverting op-amp comparator is depicted in figure.

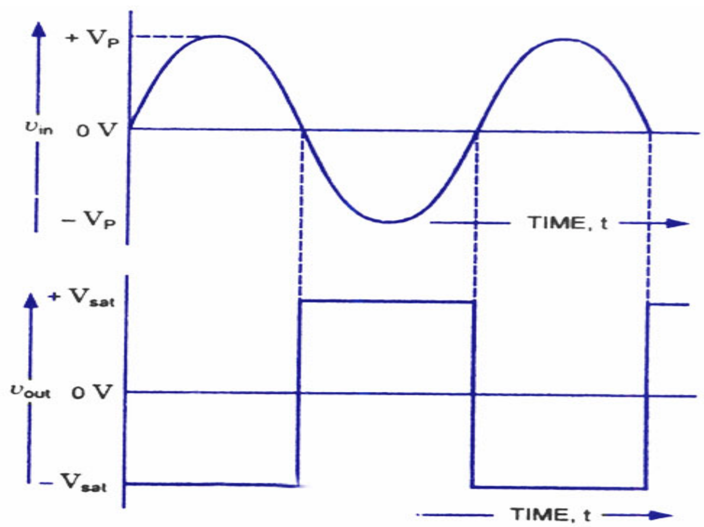
The output voltage waveform shown in figure indicates when and in what direction an input signal v_{in} crosses zero volt. In some applications the input signal may be low frequency one (i.e. input may be a slowly changing waveform). In such a case output voltage v_{OUT} may not switch quickly from one saturation state to the other. Because of the noise at the input terminals of the op-amp, there may be fluctuation in output voltage between two saturation states ($+V_{sat}$ and $-V_{sat}$ voltages). Thus zero crossings may be detected for noise voltages as well as input signal v_{in}. Both of these problems can be overcome, if we use regenerative or positive feeding causing the output voltage v_{out} to change faster and eliminating the false output transitions that may be caused due to noise at the input of the op-amp.

CIRCUIT DIAGRAM:



Circuit

MODEL GRAPH:



Input and Output Waveforms

PROCEDURE:

1. Connect the circuit as shown in the figure
2. Set the input voltage using AFO to 100mv
3. Observe the output waveform in CRO and measure the output parameter

RESULT:

Thus the characteristics of Non linear OP Amp circuit comparator and Zero crossing detector is verified.

Post Lab Questions:

1. What is a Zero-crossing detector?

2. What is a window detector?

3. Draw the characteristics of an ideal comparator and that of a commercially available comparator

4. Define the term hysteresis

RC PHASE SHIFT OSCILLATOR AND WEIN BRIDGE OSCILLATOR

Pre-Lab questions:

1. Define Barkhausen criterion for oscillations
2. State the two conditions of oscillations.
3. Classify the Oscillators
4. What is the frequency range of RC phase shift Oscillator
5. Define a wien bridge Oscillator

EXPT NO:6

DATE: **RC PHASE SHIFT OSCILLATOR AND WEIN BRIDGE OSCILLATOR**

AIM:

To design ,construct and test the RC Phase Shift Oscillator and Wein Bridge Oscillator

APPARATUS REQUIRED:

1.Op AmpIC741

2.Dual power supply

3.Resistors

4.Capacitors

5.Diode IN 4001

6.CRO

7.Bread board

8.Connecting wires

THEORY:

An oscillator is a circuit, which generates ac output signal without giving any input ac signal. This circuit is usually applied for audio frequencies only. The basic requirement for an oscillator is positive feedback.

An oscillator consists of an amplifier and a feedback network.

1) 'Active device' i.e. Op Amp is used as an amplifier.

2) Passive components such as R-C or L-C combinations are used as feed back net work.

To start the oscillation with the constant amplitude, positive feedback is not the only sufficient condition. Oscillator circuit must satisfy the following two conditions known as **Barkhausen** conditions:

i. The first condition is that the magnitude of the loop gain ($A\beta$) = 1
A = Amplifier gain and β = Feedback gain.
ii. The second condition is that the phase shift around the loop must be 360° or 0°.

RC PHASE SHIFT OSCILLATOR:

Phase-shift oscillator is a simple electronic oscillator. It contains an inverting amplifier, and a feedback filter which 'shifts' the phase of the amplifier output by 180 degrees at the oscillation frequency.The filter produces a phase shift that increases with frequency. It must have a maximum phase shift of considerably greater than 180° at high frequencies, so that the phase shift at the desired oscillation frequency is 180°.

The most common way of achieving this kind of filter is using three identical cascaded resistor-capacitor filters, which together produce a phase shift of zero at low frequencies, and 270 degrees at high frequencies. At the oscillation frequency each filter produces a phase shift of 60 degrees and the whole filter circuit produces a phase shift of 180 degrees.

DESIGN:

$$f_0 = \frac{1}{\sqrt{6}2\pi RC}$$

$R_f \geq 29R_1$

$R_1 \geq 10R$

Choose C = .1μF

f_0 = 500 Hz

$$R = \frac{1}{\sqrt{6}2\pi f_0 C} = \frac{1}{\sqrt{6}2\pi x 500 x 0.1 x 10^{-6}}$$

R = 1.3 KΩ

Choose R = 1.5KΩ

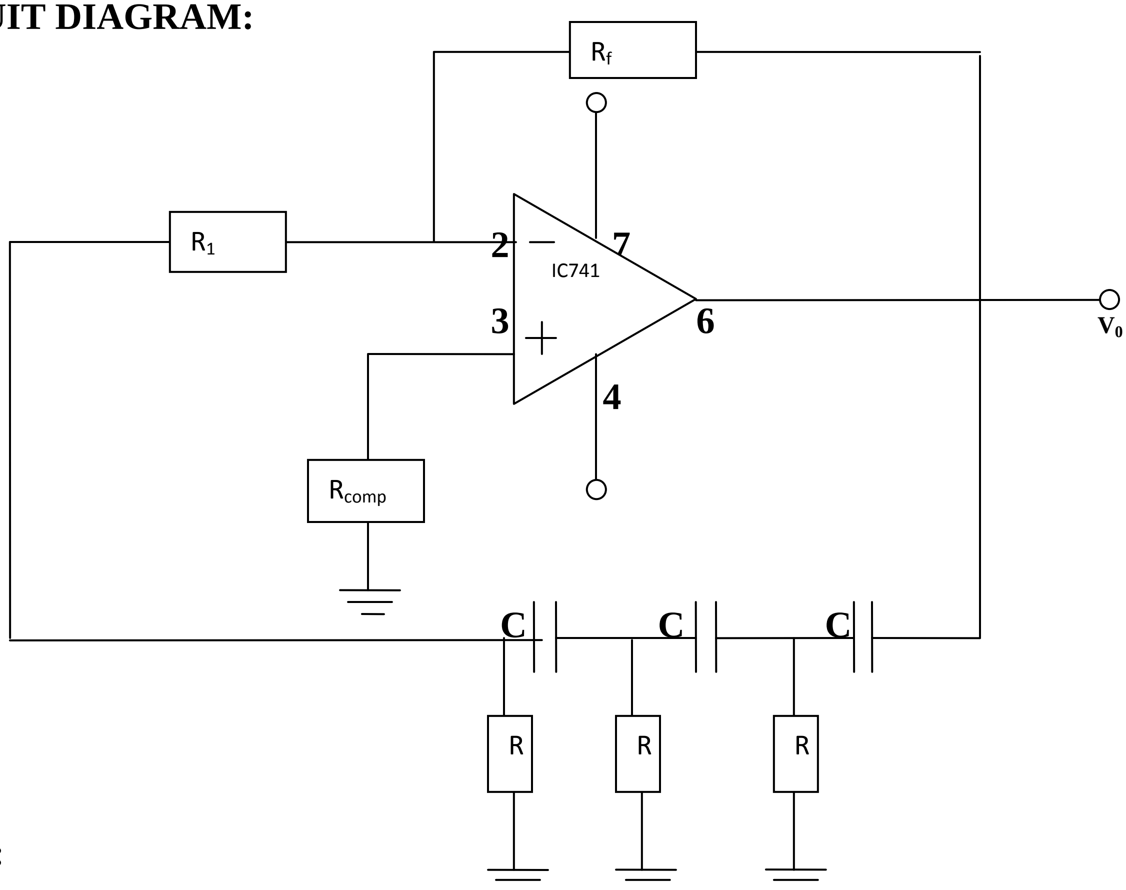
R_1≥15KΩ (to prevent loading)

Therefore,

R_1 = 10R = 15KΩ

$R_{f\,=}$ 29R1=29x15KΩ=435KΩ (Use 1MΩpot)

CIRCUIT DIAGRAM:



Values:

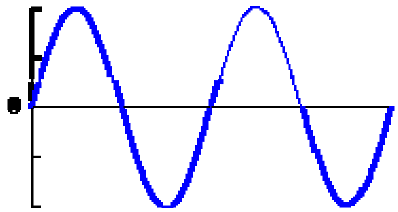
R = 1.5KΩ
C=0.1μF
R_f = 1MΩ
R1 = R_{comp} = 15KΩ

TABULATION:

INPUT			OUTPUT		
Amplitude	Time Period	Frequency	Amplitude	Time Period	Frequency

MODEL GRAPH:

Output waveform:



PROCEDURE:

RC PHASE SHIFT OSCILLATOR:

1.Design the circuit for f0=500Hz.calculate R1,R2,and Rf

2.connect the circuit as shown in the figure with the designed values.

3.Switch on the power supply and observw the waveform.

4.Note down the amplitude and time period.

5.Plot the waveforms on a graph sheet.

WEIN BRIDGE OSCILLATOR

A Wien bridge oscillator is a type of electronic oscillator that generates sine waves. It can generate a large range of frequencies. The frequency of oscillation is given by:

$$f = \frac{1}{2\pi RC}$$

The Wien Bridge Oscillator uses a feedback circuit consisting of a series RC circuit connected with a parallel RC of the same component values producing a phase delay or phase advance circuit depending upon the frequency. At the resonant frequency fr the phase shift is 0^o.Then for oscillations to occur in a Wien Bridge Oscillator circuit the following conditions must apply.:

1. With no input signal the Wien Bridge Oscillator produces output oscillations.

2. The Wien Bridge Oscillator can produce a large range of frequencies.

3. The Voltage gain of the amplifier must be at least 3.

4. The network can be used with a Non-inverting amplifier.

5. The input resistance of the amplifier must be high compared to R so that the RC network is not overloaded and alter the required conditions.

6. The output resistance of the amplifier must be low so that the effect of external loading is minimised.

7. Some method of stabilizing the amplitude of the oscillations must be provided because if the voltage gain of the amplifier is too small the desired oscillation will decay and stop and if it is too large the output amplitude rises to the value of the supply rails, which saturates the op-amp and causes the output waveform to become distorted.

8. With amplitude stabilisation in the form of feedback diodes, oscillations from the oscillator can go on indefinitely.

DESIGN:

$$f_0 = \frac{1}{2\pi RC}$$

$$A_V = 1 + \frac{R_f}{R_i} = 3$$

$$\frac{R_f}{R_i} = 2$$

R_f =2Ri

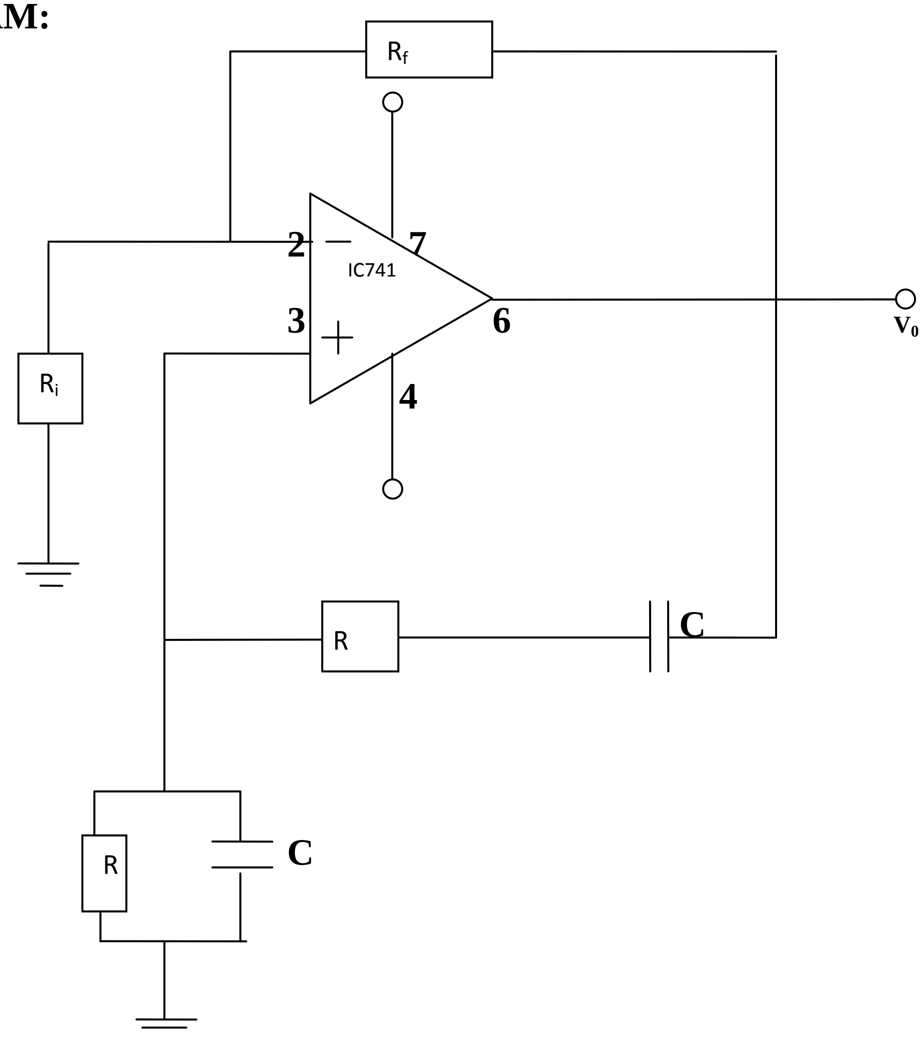
Let c = 0.047μF, f_0 = 1KHz

R = $\frac{1}{2\pi f_0 C} = 3.2K\Omega$

Let Ri = 10KΩ

$R_f = 2R_i$ = 20KΩ (use 20K pot)

CIRCUIT DIAGRAM:



Values:

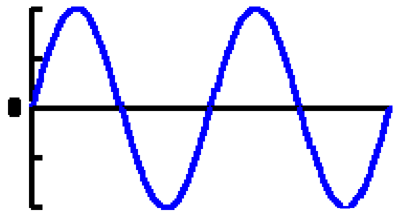
R = 3.3KΩ
C=0.047µF
R_f= 20KΩ
R1 = 10KΩ

TABULATION:

INPUT			OUTPUT		
Amplitude	Time Period	Frequency	Amplitude	Time Period	Frequency

MODEL GRAPH:

Output waveform:



PROCEDURE:

WEIN BRIDGE OSCILLATOR:

1.Design the circuit for f0=1KHz.calculate R C Rf and Ri

2.connect the circuit as shown in the figure with the designed values.

3.Switch on the power supply and observe the waveform.

4.Note down the amplitude and time period.

5.Plot the waveforms on a graph sheet.

RESULT:

Thus the RC Phase Shift oscillator and Wein Bridge oscillator are designed and constructed.

(i)RC phase shift oscillator F0=

(ii) Wein Bridge oscillator F0=

Post Lab Questions:

1. Explain how the clipping is eliminated in wien bridge oscillator
2. Draw the basic structure of a feedback oscillator.
3. What is the frequency range of LC oscillators
4. For sustained oscillations, what is the gain of the RC phase shift oscillator?
5. Design a phase shift oscillator to oscillate at 100Hz

APPLICATIONS OF TIMER IC 555

Pre-Lab questions:

1. Draw the pin diagram of 555 timer IC
2. List the applications of Monostable Multivibrator
3. Define the term Duty cycle
4. For R_a=6.8KΩ,R_b=3.3KΩand C=0.1 μF, Calculate (a)free running frequency (b) Duty cycle, D
5. Give methods for obtaining symmetrical square wave
6. Why a monostable multivibrator is called a one shot multivibrator
7. Why a Astable multivibrator is called a Free running oscillator

EXPT NO:7

DATE:

APPLICATIONS OF TIMER IC 555

AIM:

To design and study the following circuits using 555 timer.

1. MONOSTABLE MULTIVIBRATOR
2. ASTABLE MULTIVIBRATOR
3. SCHMITT TRIGGER

APPARATUS REQUIRED:

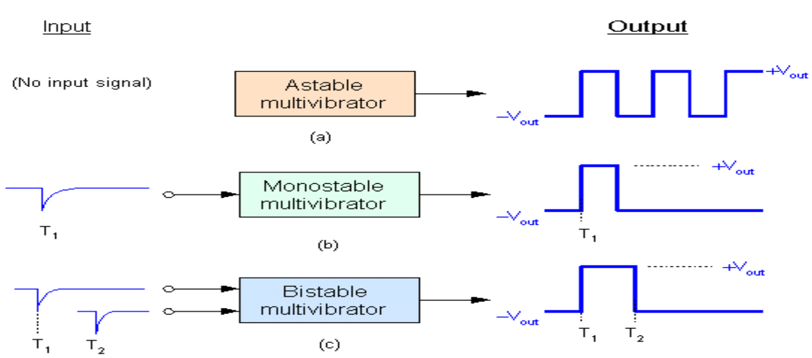
1.IC 555
2.Resistors
3.capacitors
4.CRO
5.AFO
6.RPS

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



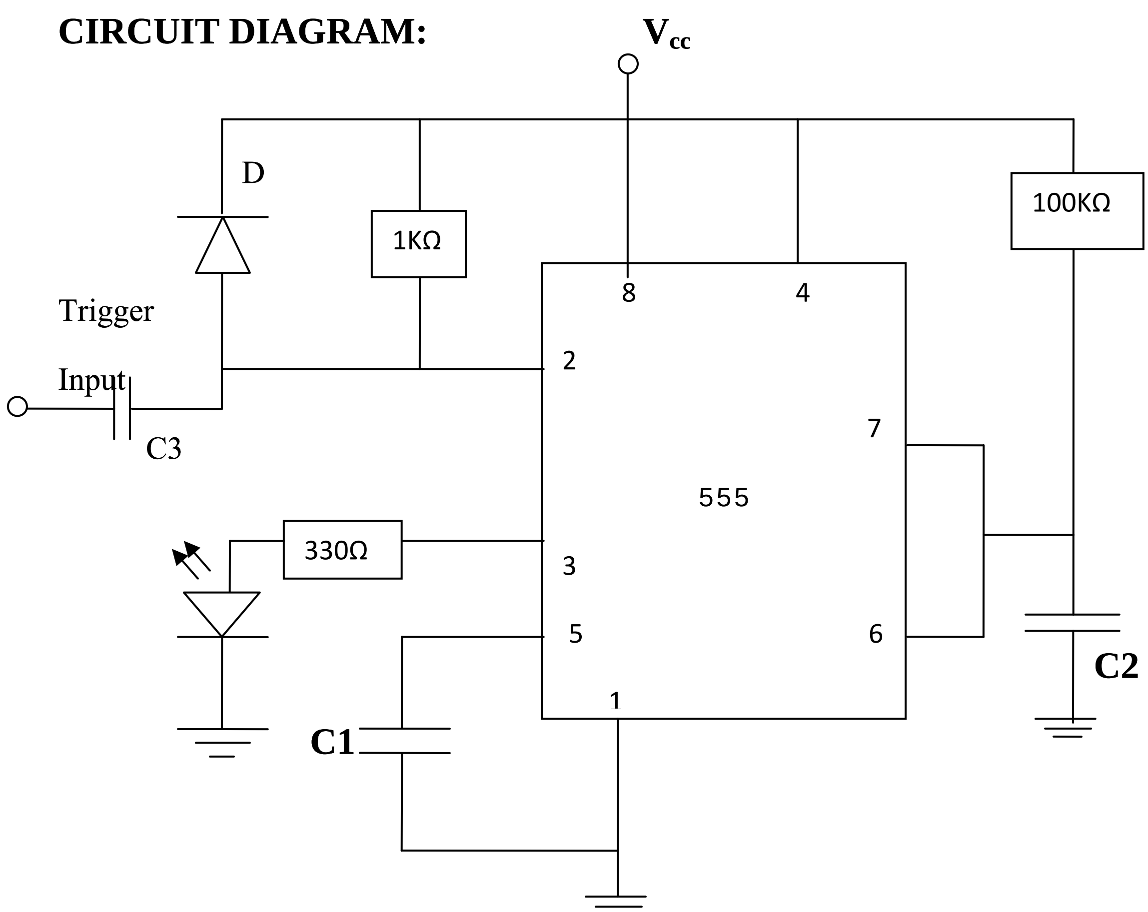
MONOSTABLE MULTIVIBRATOR

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:

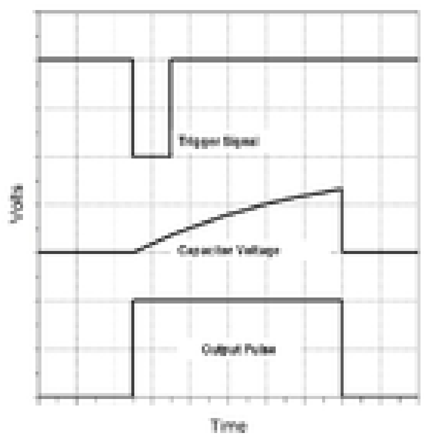


C1 = .01μf, C2 = 100μf, C3 = .001μf

TABULATION:

INPUT		OUTPUT	
AMPLITUDE	TIME PERIOD	AMPLITUDE	TIME PERIOD

MODEL GRAPH:



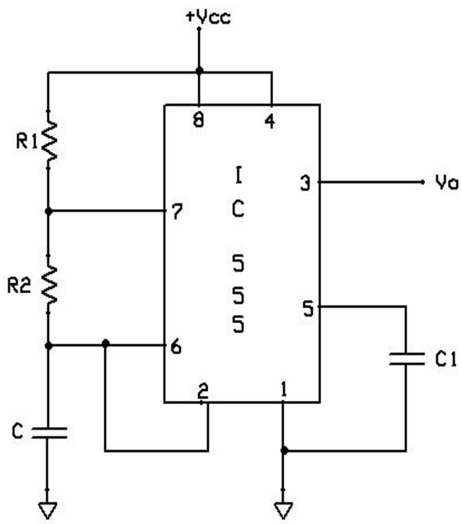
PROCEDURE:

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:



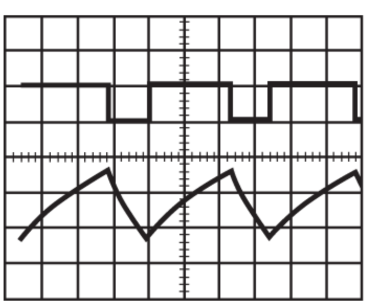
VALUES: R1=10KΩ, R2=100KΩ, C=0.1µf, C1=0.01µf

TABULATION:

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

MODEL GRAPH:

OUTPUT VOLTAGE AND CAPACITOR VOLTAGE



PROCEDURE:

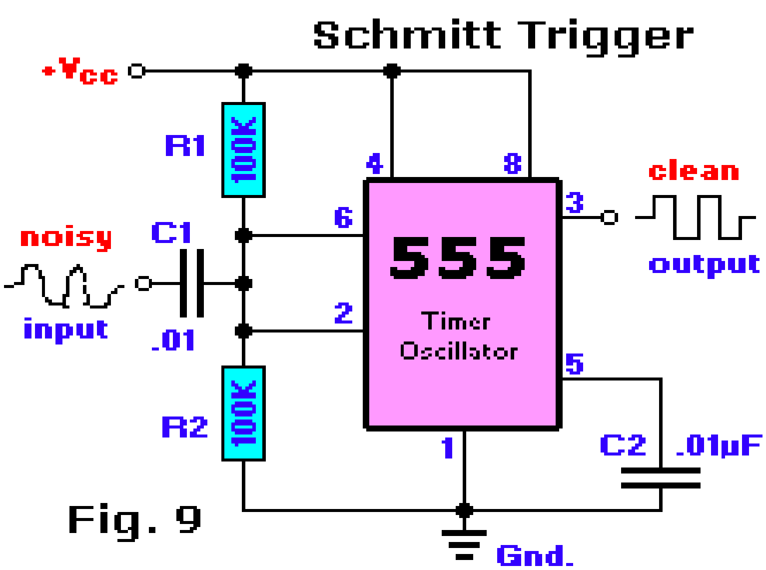
1.Connections are made as per the circuit diagram
2.A supply voltage of 5v to be given
3.The output waveforms at pin3 and pin 2 are observed on a CRO.
4.Measure Ton and toff of the waveform

SCHMITT TRIGGER:

In the Bistable mode or Schmitt trigger the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bounce free latched switches. The trigger and reset inputs (pins 2 and 4 respectively on a 555) are held high via Pull-up resistors while the threshold input (pin 6) is simply grounded. Thus configured, pulling the trigger momentarily to ground acts as a 'set' and transitions the output pin (pin 3) to Vcc (high state). Pulling the reset input to ground acts as a 'reset' and transitions the output pin to ground (low state). No capacitors are required in a bistable configuration. Pins 5 and 7 (control and discharge) are left floating.

“Bistable” signifies two stable states—high and low. In the bistable mode, the 555 acts like a Schmitt trigger.A Schmitt trigger produces an output when the input exceeds a specified level. The output continues until the input falls below a specified level. With the 555, a trigger at one input sets the output to high; a trigger at another input sets the output to low. The output retains its value until the input changes sufficiently to trigger a state change.

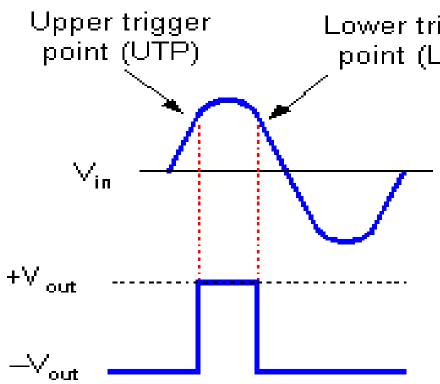
CIRCUIT DIAGRAM:



TABULATION:

INPUT		OUTPUT		
Amplitude	Time period	Amplitude	Time period	
			ON time	OFF time

MODEL GRAPH:



PROCEDURE:

1.Construct the circuit as shown in the figure

2. observe the output waveform of schmitt trigger circuit by giving sinewave as input

3.Note down the amplitude and time period and draw the output waveform

RESULT:

Thus the Monostable multivibrator ,Astable multivibrator and Schmitt Trigger circuits are designed and constructed and the output waveforms are drawn.

Post Lab Questions:

1. Discuss the operation of a FSK generator using 555 timer.
2. How is an Astable multivibrator connected into a pulse position modulator.
3. Explain the function of reset?
4. What are the modes of operation of a timer?
5. Derive the expression of time delay of a monostable multivibrator.

STUDY OF TIMER IC 555

Pre-Lab questions:

1. Draw the pin diagram of 555 timer IC
2. What are the features of 555 Timer IC
3. Give the applications of Timer IC 555
4. Define Flip flop
5. What is a comparator? what are the applications of comparator

EXPT NO:8

DATE:

STUDY OF TIMER IC 555

AIM:

To study the characteristics of IC 555 Timer

APPARATUS REQUIRED:

1.IC 555

2.Resistors

3.capacitors

4.CRO

5.AFO

6.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: in this mode, the 555 functions as a "one-shot" pulse generator. Applications include timers, missing pulse detection, bouncefree switches, touch switches, frequency divider, capacitance measurement, pulse-width modulation (PWM) and so on.
- Astable – free running mode: the 555 can operate as an oscillator. Uses include LED and lamp flashers, pulse generation, logic clocks, tone generation, security alarms, pulse position modulation and so on. Selecting a NTC as timing resistor allows the use of the 555 in a temperature sensor: the period of the output pulse is determined by the temperature. The use of a microprocessor based circuit can then convert the pulse period to temperature, linearize it and even provide calibration means.
- Bistable mode or Schmitt trigger: the 555 can operate as a flip-flop, if the DIS pin is not connected and no capacitor is used. Uses include bounce free latched switches.

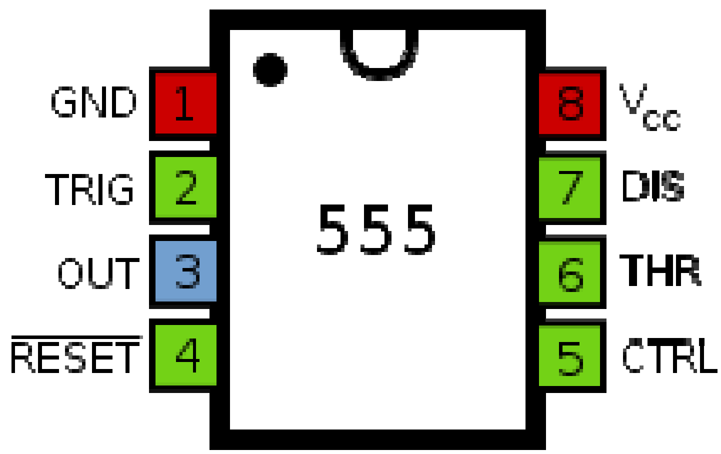
The important features of the 555 timer are :

- It operates from a wide range of power supplies ranging from + 5 Volts to + 18 Volts supply voltage.
- Sinking or sourcing 200 mA of load current.
- The external components should be selected properly so that the timing intervals can be made into several minutes Proper selection of only a few external components allows

timing intervals of several minutes along with the frequencies exceeding several hundred kilo hertz.

- It has a high current output; the output can drive TTL.
- It has a temperature stability of 50 parts per million (ppm) per degree Celsius change in temperature, or equivalently 0.005 %/ °C.
- The duty cycle of the timer is adjustable with the maximum power dissipation per package is 600 mW and its trigger and reset inputs are logic compatible.

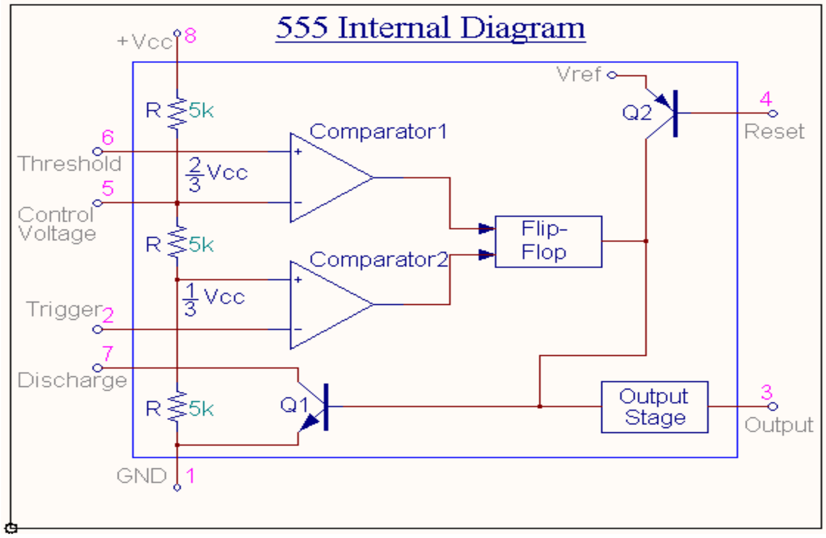
IC PIN CONFIGURATION:



The connection of the pins is as follows:

PIN	NAME	PURPOSE
1	GROUND	Ground, low level (0 V)
2	TRIGGER	OUT rises, and interval starts, when this input falls below 1/3 V_{CC}.
3	OUTPUT	This output is driven to $+V_{CC}$ or GND.
4	RESET	Active low- interrupts the timing interval at Output.
5	CONTROL VOLTAGE	"Control" access to the internal voltage divider (by default, 2/3 V_{CC}).
6	THRESHOLD	The interval ends when the voltage at THR is greater than at CTRL.
7	DISCHARGE	Open collector output; may discharge a capacitor between intervals
8	V_{CC}	Positive supply voltage is usually between 3 and 15 V.

Block Diagram:



The block diagram of a 555 timer is shown in the above figure. A 555 timer has two comparators, (which are basically 2 op-amps), an R-S flip-flop, two transistors and a resistive network.

- Resistive network consists of three equal resistors and acts as a voltage divider.
- Comparator 1 compares threshold voltage with a reference voltage + $2/3\ V_{CC}$ volts.
- Comparator 2 compares the trigger voltage with a reference voltage + $1/3\ V_{CC}$ volts.

Output of both the comparators is supplied to the flip-flop. Flip-flop assumes its state according to the output of the two comparators. One of the two transistors is a discharge transistor of which collector is connected to pin 7. This transistor saturates or cuts-off according to the output state of the flip-flop. The saturated transistor provides a discharge path to a capacitor connected externally. Base of another transistor is connected to a reset terminal. A pulse applied to this terminal resets the whole timer irrespective of any input.

Working Principle:

Comparator 1 has a threshold input (pin 6) and a control input (pin 5). In most applications, the control input is not used, so that the control voltage equals +2/3 V_{CC}. Output of this comparator is applied to set (S) input of the flip-flop. Whenever the threshold voltage exceeds the control voltage, comparator 1 will set the flip-flop and its output is high. *A* high output from the flip-flop saturates the discharge transistor and discharge the capacitor connected externally to pin 7. The complementary signal out of the flip-flop goes to pin 3, the output. The output available at pin 3 is low. These conditions will prevail until comparator 2 triggers the flip-flop. Even if the voltage at the threshold input falls below 2/3 V_{CC}, that is comparator 1 cannot cause the flip-flop to change again. It means that the comparator 1 can only force the flip-flop's output high.

To change the output of flip-flop to low, the voltage at the trigger input must fall below + 1/3 Vcc. When this occurs, comparator 2 triggers the flip-flop, forcing its output low. The low output from the flip-flop turns the discharge transistor off and forces the power amplifier to output a high. These conditions will continue independent of the voltage on the trigger input. Comparator 2 can only cause the flip-flop to output low.From the above discussion it is concluded that for the having low output from the timer 555, the voltage on the threshold input must exceed the control voltage or + 2/3 V_{CC}. They also turn the discharge transistor on. To force the output from the timer high, the voltage on the trigger input must drop below +1/3 V_{CC}. This also turns the discharge transistor off.

A voltage may be applied to the control input to change the levels at which the switching occurs. When not in use, a 0.01 nano Farad capacitor should be connected between pin 5 and ground to prevent noise coupled onto this pin from causing false triggering.Connecting the reset (pin 4) to a logic low will place a high on the output of flip-flop. The discharge transistor will go on and the power amplifier will output a low. This condition will continue until reset is taken high. This allows synchronization or resetting of the circuit's operation. When not in use, reset should be tied to +V_{CC}.

RESULT:

Thus the functions of IC 555 Timer is studied

Post Lab Questions:

1. Discuss the operation of a FSK generator using 555 timer.
2. How is an Astable multivibrator connected into a pulse position modulator.
3. Explain the function of reset?
4. What are the modes of operation of a timer?
5. Derive the expression of time delay of a monostable multivibrator.

STUDY OF FUNCTION GENERATOR IC566

Pre-Lab questions:

1. Draw the pin diagram of NE/SE 566.
2. What are the types of waveforms that are able to generate by using a function generator.
3. Draw the transfer characteristics of sine shaper circuit.
4. What are the conditions of a self-sustained oscillation?
5. List some applications of Function Generator.

EXPT NO:9

DATE: **STUDY OF FUNCTION GENERATOR IC566**

AIM:

To study the function of voltage controlled oscillator IC 566 and to generate the square wave and triangular wave using the same.

APPARATUS REQUIRED:

1.IC 566

2.Resistors

3.capacitors

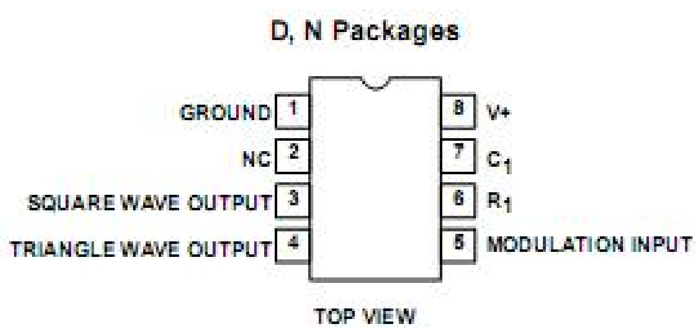
4.Regulated power Supply

5.Cathode Ray Oscilloscope

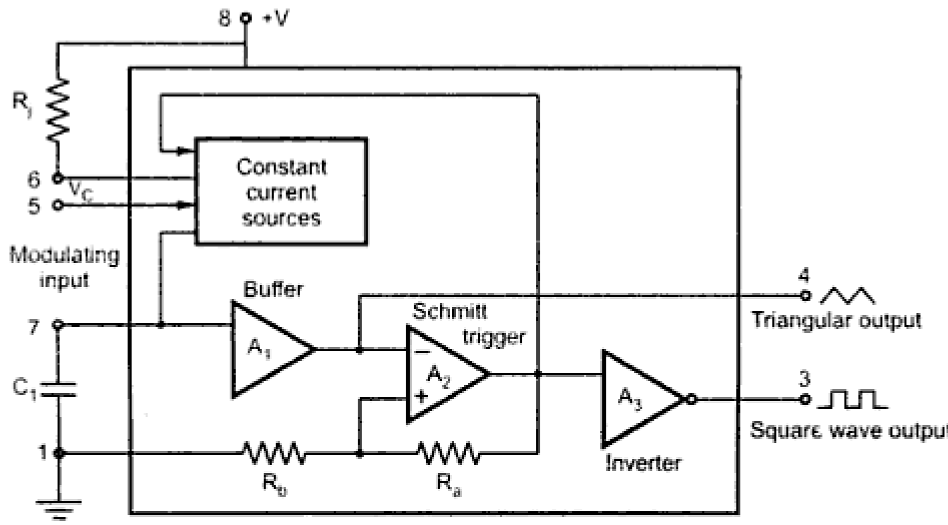
THEORY:

A Voltage-Controlled Oscillator (VCO) is a circuit that provides a varying output signal (typically of square-wave or triangular-wave form) whose frequency can be adjusted over a range controlled by a dc voltage. An example of a VCO is the **566** IC unit, which contains circuitry to generate both squarewave and triangular-wave signals whose frequency is set by an external resistor and capacitor and then varied by an applied dc voltage.

PIN DIAGRAM OF NE566:



BLOCK DIAGRAM OF NE566:



OPERATION:

The Op amp A1 is used as a buffer. The Op amp A2 is used as a schmitt trigger and the Op amp A3 is used as a inverter.The voltage Vc is applied to the modulation input pin,which is a control voltage.

The capacitor C1 is linearly charged or discharged by a constant current source.The charging current can be controlled by controlling thevoltage vc at pin5 or by varying the resistance R1 which is external to the IC.The charging and discharging levels are determined by the schmitt trigger.

The output voltage of the schmitt trigger is designed to swing between+v and 0.5v.For Ra=Rb the voltage at non inverting terminal swingsbetween 0.5(+v) to 0.25(+v).Thus the triangular wave is generated due to charging and discharging of the capacitor c1,in linear manner.when c1 voltage increases beyond 0.5(+v) the schmitt trigger output goes low,and the capacitor starts discharging.when the voltage becomes less than 0.25(+v) the schmitt trigger output goes high,Due to similar current sources used for charging and discharging the time taken by c1 to charge and discharge is same.This produces exact triangular wave.The output of the schmitt trigger is step response which is available at pin 3 as a square wave output.

The frequency of the output waveform is $f_0 = \dfrac{2(+V - V_c)}{C_1 R_1 (+V)}$

FEATURES:

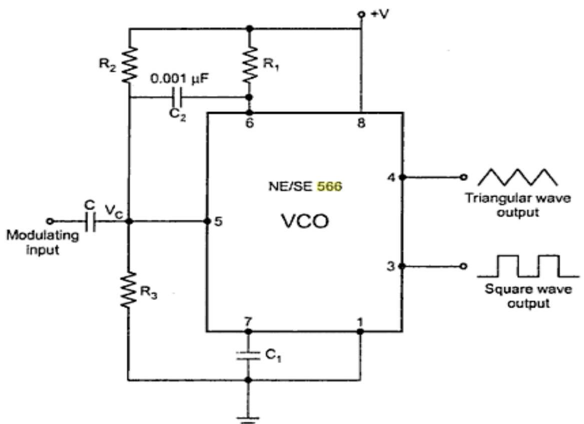
- Wide range of operating voltage (up to 24V; single or dual)
- High linearity of modulation
- Highly stable center frequency (200ppm/°C typical)

• Highly linear triangle wave output
• Frequency programming by means of a resistor or capacitor, voltage or current
• Frequency adjustable over 10-to-1 range with same capacitor

APPLICATIONS:

• Tone generators
• Frequency shift keying
• FM modulators
• Clock generators
• Signal generators
• Function generators

CIRCUIT DIAGRAM:



TABULATION:

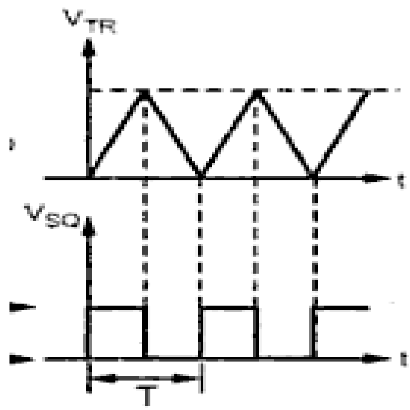
Output at Pin 3:

Amplitude	Time period

Output at Pin 4:

Amplitude	Charging time of capacitor	Discharging time of capacitor

MODEL GRAPH:



PROCEDURE:

1.Construct a voltage controlled oscillator using IC 566 as shown in the figure

2.Give the modulating voltage Vc to the input.

3.Observe the output waveforms in the respective pins using a CRO.

RESULT:

Thus the function of IC 566 is studied and by using the same the square and triangular waves are generated.

Post Lab Questions:

1. What is the widely used monolithic IC that can be used to build a function generator.
2. Draw the pin configuration of XR-2206 monolithic IC.
3. Define the term Duty cycle.
4. Give the block diagram representation of NE 566.
5. What is the purpose of using Constant current source in NE 566.