ANALOG INTEGARETED ELECTRONIC LAB

(EEC: 509)

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SYALLBUS

EEC -509: ANALOG INTEGRATED ELECTRONICS LAB

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1. To determine CMRR of a differential amplifier.
2. To study op-amp based inverting and non-inverting amplifiers, voltage comparator and zero crossing detector.
3. To study op-amp based Adder and integrator circuits.
4. To study RC low pass and high pass active filters and draw outlput voltage waveform for square wave input.
5. To study Op-Amp based triangular wave generator.
6. To study operation of IC74123 as monostablemultivibrator.
7. To design and fabricate Op-Amp. Base astablemultivibrator and verify experimentally frequency of oscillation.
8. To study operation of IC NE/SE 566 voltage controlled oscillator and determine output frequency for various voltage levels.
9. To study Op-Amp. Based V to I and I to V converters.
10. To study a PLL circuit and determine the free running frequency.
11. To study Op-Amp. based sample and hold circuit.
12. To study Instrumentation Amplifier circuit.

LIST OF EXPERIMENTS

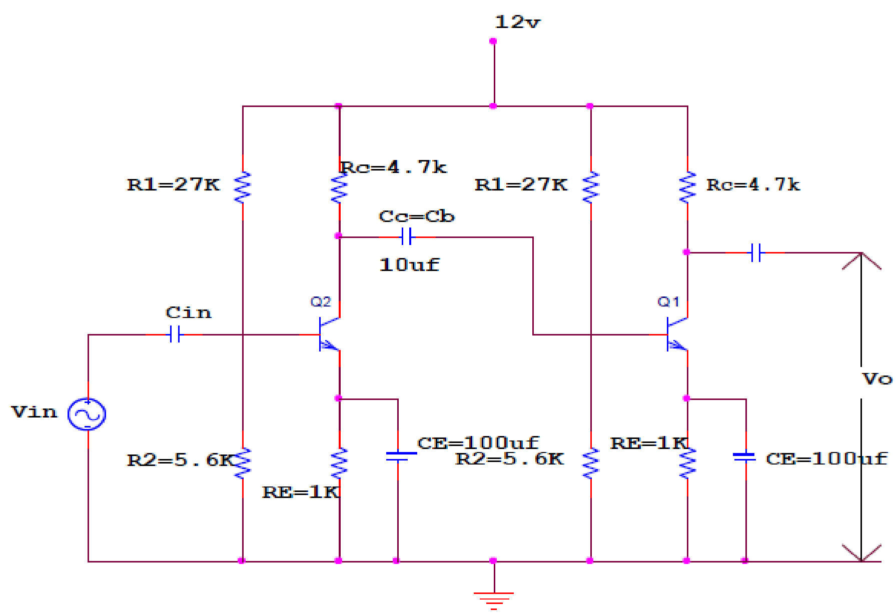
EXPERIMENT No. 1

AIM: - Design & measure the frequency response of an RC coupled amplifier using discrete components.

APPARATUS REQUIRED: - CRO, function generator, breadboard, transistor BC 104 (2 pcs), capacitor10μF (3 pcs), 100μF (2pcs), resistor 4.7K (2pcs), 5.6K (2pcs), 1K (2pcs), ± 12 V supply and connecting leads.

THEORY: - RC coupled amplifier is a coupling of two emitter biased transistor circuit to form a single cascade network. The output Vi of one stage is coupled to the input of the next stage. A blocking capacitor is used to keep the DC component f the output voltage at Vo1. The emitter resistor R_E and resistor R_1 and R_2 are used for biasing. The bypass capacitor is used to present loss of Amplification due to negative feedback. Output is taken across capacitor Cc.

CIRCUIT DIAGRAM: -



RC COUPLED AMPLIFIER

PROCEDURE: -

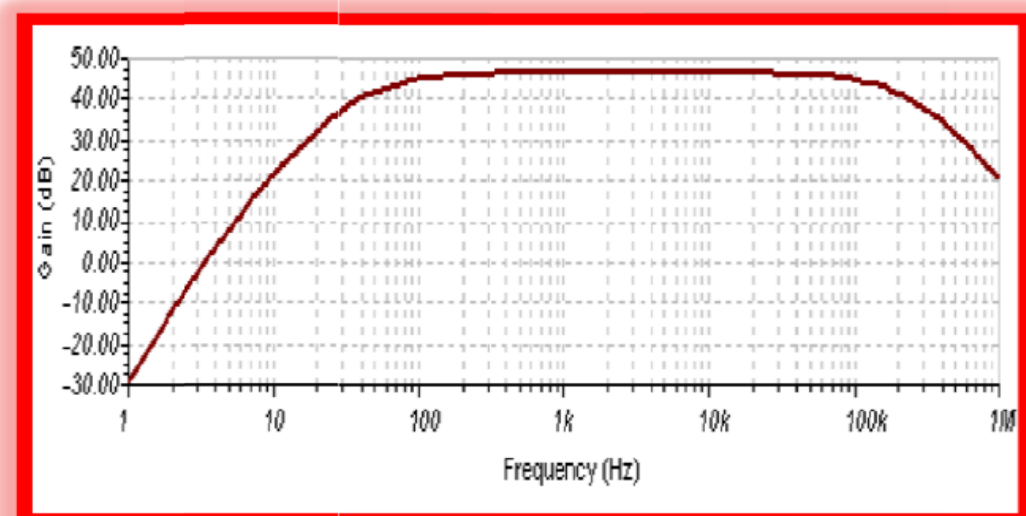
(1) Apply input signal of 10 mv amplitude and frequency 50 Hz at input terminal.
(2) Varying the frequency of the input signal from 10Hz to1MHz.
(3) Measure the output signal amplitude.
(4) Study the frequency response characteristics of RC coupled amplifier.
(5) Determine lower cut-off frequency and upper cut-off frequency from the graph.
(6) Calculate Bandwidth.

OBSERVATION TABLE:-

INPUT VOLTAGE (Vin) = Constant

S.NO.	FREQUENCY (Hz)	OUTPUT VOLTAGE (Vout)	GAIN (Vout/ Vin) IN dB

FREQUENCY RESPONSE & BANDWIDTH CALCULTION:-



PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be Switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DISCUSSION: – What is the application of RC coupled amplifier?

RESULT: - The output of RC coupled amplifier is a sinusoidal wave having same phase as the input signal.

QUIZ QUESTIONS WITH ANSWERS:-

Q1. In RC coupled amplifier which component is responsible for reduction in voltage gain in the high frequency range?
Ans. Shunt capacitance in the input circuit.

Q2. In RC coupled amplifier which component's value is responsible for low 3-dB frequency?
Ans. Increasing the value of coupling capacitor C_b.

Q3. In RC coupled amplifier which component's value is responsible for high 3-dB frequency?
Ans. By reducing the total effective shunt capacitance in the input circuit of hybrid pie model.

Q4. In a single stage RC coupled amplifier, what is the phase shift introduced in the true middle frequency?
Ans. 180°

Q5. Which type of coupling capacitor is used in RC coupled amplifier?
Ans. 0.05 μf paper capacitor.

Q6. What is the application of RC coupled amplifier?
Ans. It is widely used as a voltage amplifier.

Q7. In single stage RC coupled amplifier, what is the phase shift at low 3-dB frequency?
Ans. 225°

Q8. In single stage RC coupled amplifier, what is the phase shift at high 3-dB frequency?
Ans. 135°

Q9. In RC coupled amplifier what is the effect of low 3-dB frequency by increasing the value of coupling capacitor C_b?
Ans. Decreasing.

Q10. In RC coupled amplifier what is the effect of low 3-dB frequency by increasing the value of total effective shunt capacitor?
Ans. Decreasing.

EXPERIMENT NO. 2

AIM:-Design a two stage RC coupled amplifier and determine the effect of cascading on gain and bandwidth.

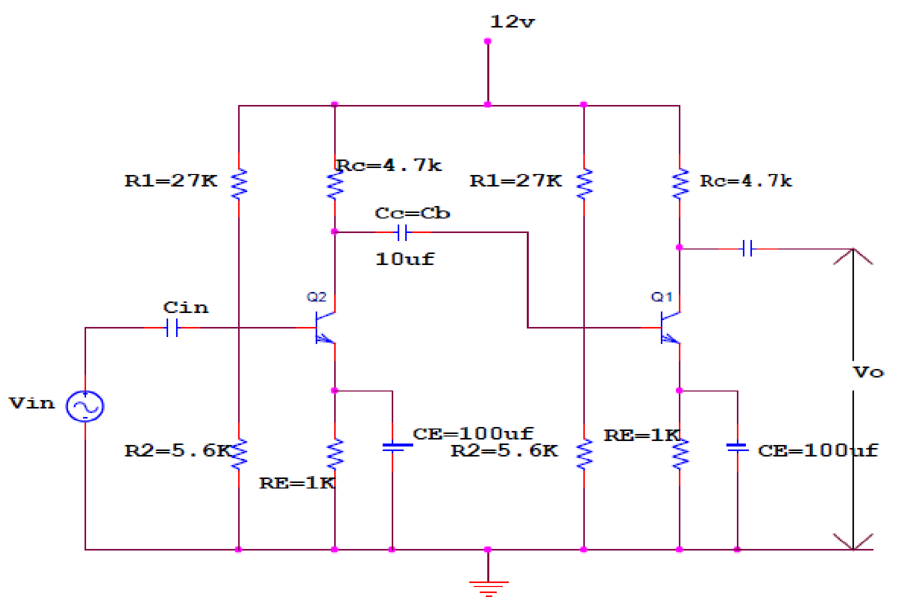
APPARATUS REQUIRED: - CRO, function generator, breadboard, transistor BC 104 (2 pcs), capacitor10μF (3 pcs), 100μF (2pcs), resistor 4.7K (2pcs), 5.6K (2pcs), 1K (2pcs), ± 12 V supply and connecting leads.

THEORY: - When the voltage gain provided by a single stage is not sufficient, we use more than one stage of the amplifier. The overall gain of the two-stages is given by

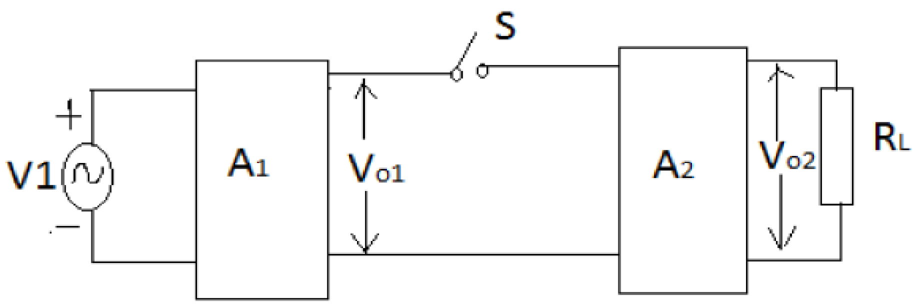
$$A=A_1 * A_2$$

Where A_1 is the voltage gain of first stage and A_2 is the voltage gain of the second stage. When the load resistance of first stage is reduced, the gain and hence output voltage also reduces.

CIRCUIT DIAGRAM:-



RC COUPLED AMPLIFIER



Two Stage amplifier (Block Diagram)

PROCEDURE: -

(1) Connect the circuit properly.
(2) Feed the ac signal at input of first stage. Adjust the frequency at 1 KHZ. See the output wave shapes on the CRO.
(3) Go on increasing the input ac voltage and measure ac voltage at (i) output of first stage (ii) output of second stage
(4) Repeat the same experiment with a single stage by opening the switch 'S'.
(5) Disconnect the second stage and then measure the output voltage of the first stage. Calculate the voltage gain of first stage under this condition and compare it with overall voltage gain of two stage amplifier.

OBSERVATIONS:-

1. Voltage Gain

S.No.	Input Voltage	Output of First stage	Output of Second stage	A_1	A_2	$A=A_1* A_2$
1.						
2.						

2. Voltage gain with second stage disconnected

S.No.	Input Voltage	Output of First stage	Gain (A_1)
1.			
2.			

RESULT:-

1. Two stage amplifier gain= ………. db
Single stage amplifier gain= ……… db
Overall voltage gain of two stage amplifier is higher than single stage amplifier.
Gain of two stage amplifier is equal to the product of gains of individual stages. In practice total gain A is less than A1*A2 due to loading effect of following stages.

2. Bandwidth = upper cut-off frequency- lower cut off frequency (From Exp. 1)

EXPERIMENT NO. 3

AIM: - Study the effect of voltage series, current series, voltage shunt and current shunt feedback on amplifier using discrete components.

THEORY:-

Voltage Series Feedback:-This is also called the shunt-derived series feedback. In this circuit, Amplifier and feedback network are connected in series-parallel. A fraction of the output voltage is applied in series opposition to the input voltage through feedback network. The feedback voltage is derived from the voltage divider circuit formed of resistors R1 and R2. The feedback voltage is given as:

$$V_f = \beta\ V_{out} = R1/R1+R2V_{out}$$

$$\text{Thus } \beta = R1/R1+R2$$

And the overall gain of the amplifier is:

$$A_f = V_{out}\ /V_s = R1+R2/R1 = 1/\ \beta$$

Voltage Shunt Feedback:- This is also called the shunt-derived shunt feedback. A small portion of the output voltage is coupled back to the input voltage since the feedback network shunt both the input and output of the amplifier, both the input and output impedances are reduced by a factor 1/ (1+ β A).

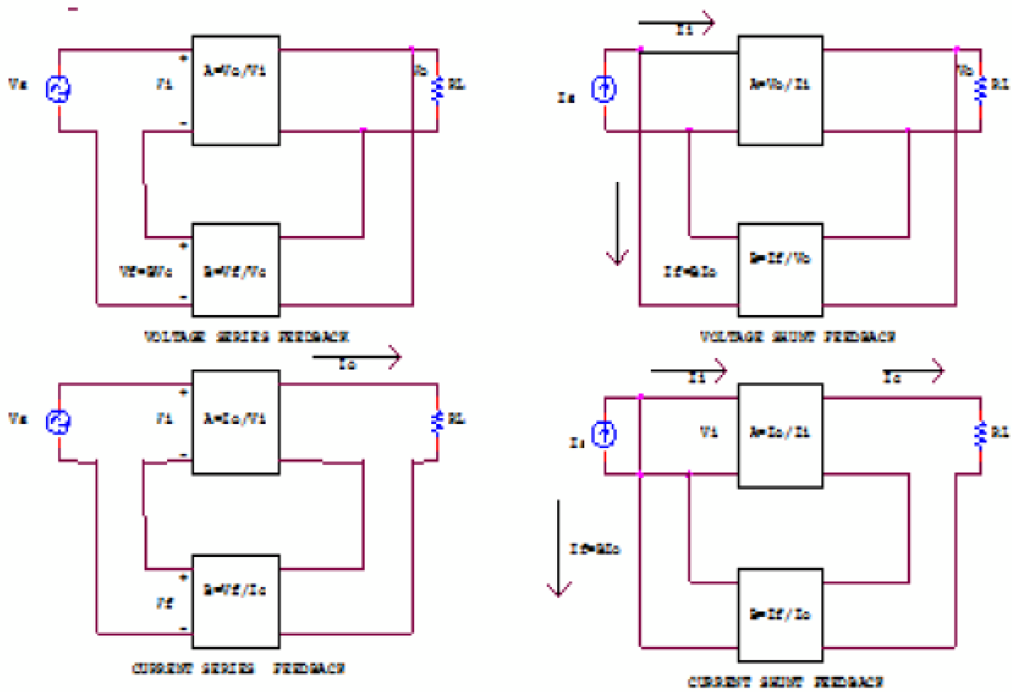
The feedback is proportional to the output voltage V_{out} and feedback current I_f. $I_f$gets added in shunt with the input. Thus this circuit from the case of voltage shunt inverse feedback amplifier.

Feedback current, $I_f = V_{in} - V_{out}/R_F = Vout/RF = \beta V_{out}$

Current Series Feedback: - This is also called the series derived series feedback. In such a feedback circuit, a part of the output current is made to develop voltage proportional to the output current and supplied back in series with the input .Since feedback network is in series with the amplifier on the output end as well as on the input end , both input and output impedances are increased with negative feedback. The current feedback can be obtained by removing the bypass capacitor across the emitter resistor R_E.

Current Shunt Feedback: - It is also known as series derived shunt feed feedback or current shunt inverse feedback. In this circuit the feedback network pick up a part of the output current and produces a feedback voltage in parallel with the input signal voltage. input impedance is reduced with feedback where as the output impedance is increased because of feedback network being in series with the output.

CIRCUIT DIAGRAM:-



DISCUSSION:-What are the applications of voltage series feedback amplifier?

RESULT:-Series and parallel voltage & current feedback circuit have been studied.

EXPERIMENT NO:4

AIM:-Design and realize Inverting, Non-Inverting and buffer amplifier using 741 Op-amp.

APPARATUS REQUIRED: - CRO, Function Generator, Bread Board, 741 IC, ± 12V supply, resistors1KΩ, 10KΩ, and connecting leads.

THEORY: - The op-amp is a multi-terminal device used in a number of electronic circuits.

Inverting Amplifier: - In the inverting amplifier only one input is applied and that is to the inverting input (V2) terminal. The non-inverting input terminal (V1) is grounded.

Since,

$$V1 = 0\ V\ \&\ V2 = V_{in}$$
$$Vo = -Av_{in}$$

The negative sign indicates the output voltage is 180' out of phase with respect to the input and amplified by gain A.

Non-Inverting Amplifier: - The input is applied to the non-inverting input terminal and the Inverting terminal is connected to the ground.

$$V1 = V_{in} \text{ and } V2 = 0 \text{ volts}$$
$$Vo = Av_{in}$$

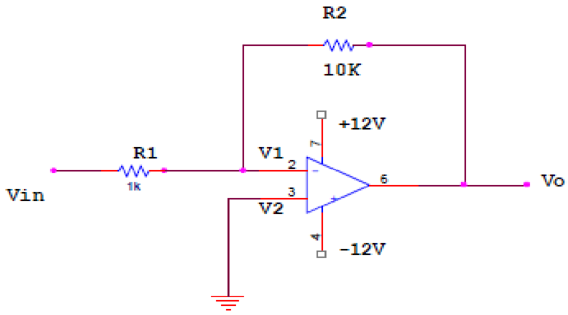
The output voltage is larger than the input voltage by gain A & is in phase with the input signal.

Buffer amplifier:-The lowest gain that can be obtained from a non-inverting amplifier with Unity feedback. When the non-inverting amplifier is for unity gain it is called a voltage follower because the output voltage is equal to and in phase with the input .In the Voltage follower the output follows the input Since the voltage follower is a special case of the non inverting amplifier, all the Formulae developed for the latter are applicable to the former aspect that the gain of the feedback circuit is UNITY.

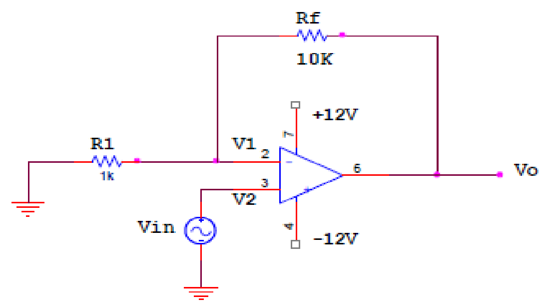
$$A_f = 1$$
$$R(if) = A\,Ri$$
$$R(of) = Ro/A$$
$$Vo = \pm Vsat/A$$
$$\text{Since } (1+A) \cong A$$

The voltage follower is also called a non inverting buffer because, when placed between two networks, it removes the loading on the first network.

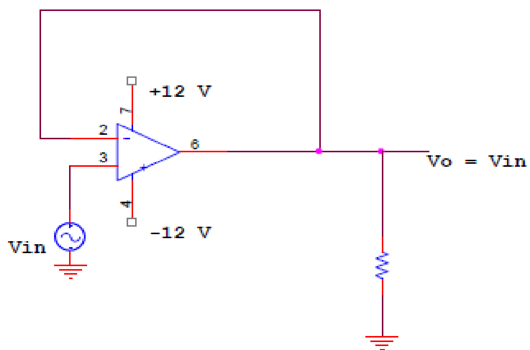
CIRCUIT DIAGRAM: -



INVERTING AMPLIFIER



NON-INVERTING AMPLIFIER



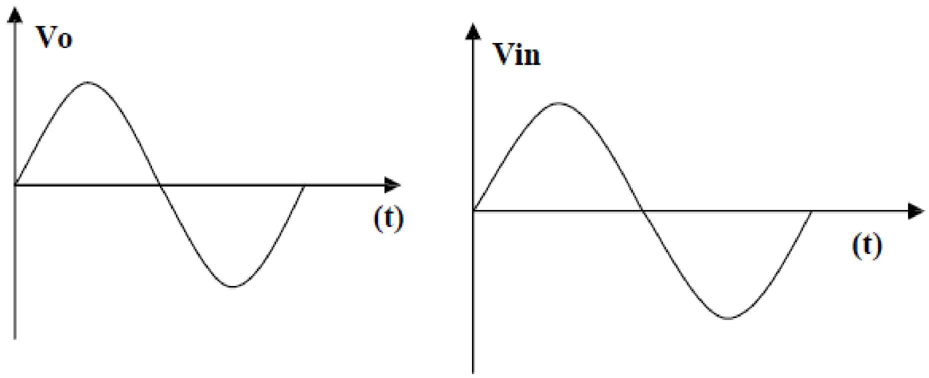
BUFFER AMPLIFIER

PROCEDURE: -

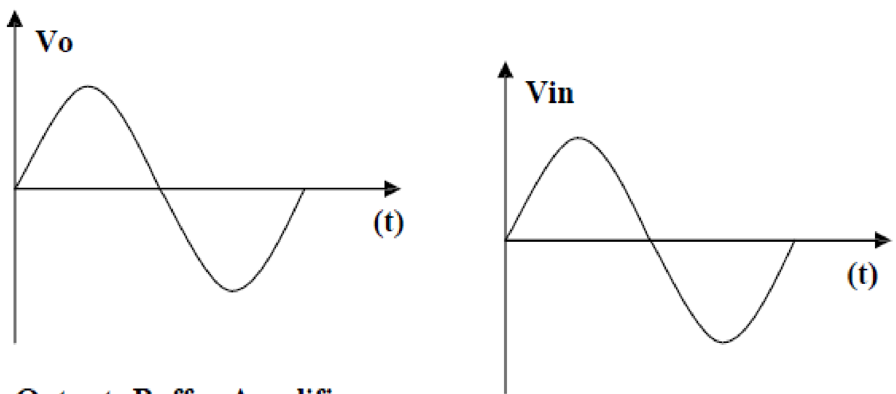
(1) Connect the circuit for inverting, non-inverting and buffer amplifier on a breadboard.
(2) Connect the input terminal of the op-amp to function generator and output terminal to CRO.
(3) Feed input from function generator and observe the output on CRO.
(4) Draw the input and output waveforms on graph paper.

OUTPUT WAVEFORM:-

Output: Inverting Amplifier



Output: Non- Inverting Amplifier



Output: Buffer Amplifier

PRECAUTIONS:-

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3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DISCUSSIONS:-What are the application of inverting, non-inverting and buffer amplifier?

RESULT: - Amplified output waveforms are obtained.

EXPERIMENT NO.5

AIM: - Verify the operation of a differentiator circuit using op amp 741 and show that it acts as a high pass filter.

APPARATUS REQUIRED:- CRO, Function Generator, ± 12 Supply, Connecting Leads, 741 IC, capacitor 0.1μf, resistor 1KΩ, Breadboard.

THEORY: - Differentiator circuit as its name implies, performs the mathematical operation of differentiation, that is, the output waveform is the derivative of the input. The differentiator may be constructed from a basic inverting amplifier when an input resistor R_1 is replaced by a capacitor C,

$$V_o = - R_f\ C\ dV_{in}/dt$$

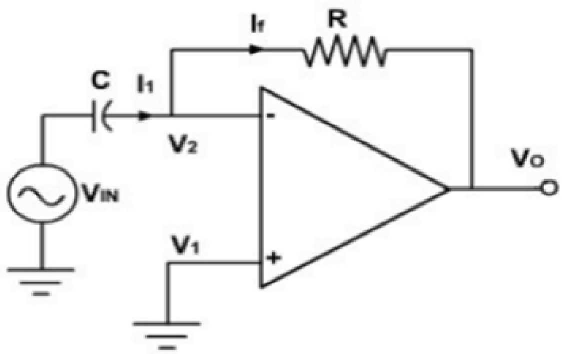
Thus, the output Vo is equal to the R_f C times the negative instantaneous rate of change of the input voltage V_{in} with time. The true differentiation is a form of high pass filtering.

$$H(j\omega) = -Z_f / Zi = -R_f / 1/j\omega C$$

$$H(j\omega) = - R_f\ j\omega C$$

Magnitude of H $(j\omega)$ is M (ω) = ωR_f C The function is very small at low frequencies but increases linearly as the frequency increases. This explanation indicates that true differentiator is a form of high, pass filtering.

CIRCUIT DIAGRAM:-



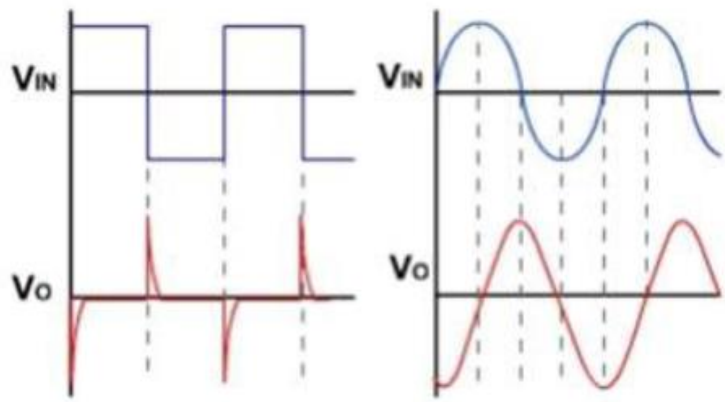
PROCEDURE: -

(1) Connect the circuit. according to the circuit diagram.
(2) Apply square wave to the input terminal of differentiator circuit.
(3) Set the input voltage at 1V peak to peak and frequency at 1 KHz.
(4) Note down the input and output waveform.

OBSERVATION TABLE:-

S.NO	I/P Voltage Vin	O/P Voltage Vo	Frequency in KHz.	Gain=20log V0/Vin

GRAPH:-



PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DISCUSSION: - What is the application of differentiator?

RESULT: -Wave forms shows integrator is a high pass filter.

EXPERIMENT NO. 6

AIM: - Verify the operation of Integrator circuit using op amp 741 and show that it acts as a low pass filter.

APPARATUS REQUIRED: - CRO, Function generator, ±12V supply, 741 IC, Breadboard, Resistors10KΩ, 1KΩ, capacitor 0.1µf and connecting leads

THEORY: - A circuit in which the output waveform is the integral of the input wave is the integrator. Such a circuit is obtained by using a basic inverting amplifier configuration. If the feedback resistor R_f is replaced by a capacitor C. The output voltage can be obtained by,

$$Vo = - 1/ R C_f \int Vin\, dt + C$$

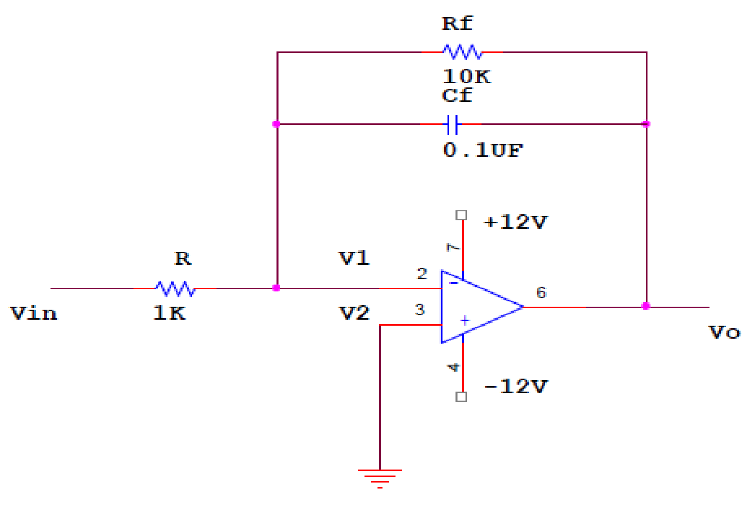
Where C is the integration constant and proportional to the value of the output Voltage Vo at time t = 0 sec. Thus, the output voltage is directly proportional to the negative integral of the input voltage and inversely proportional to the time constant R C_f. The convenient way to introduce the AC integration circuit is through frequency response and impedance consideration. The transfer function for the true integrator is given by

$$H (j\omega) = - Zf / Zi = -\frac{1/j\omega c}{R}$$

$$H (j\omega) = - 1/ j\omega cR$$

Amplitude response, M (ω) = 1 / ωRC It is clear that integration is a form of low pass filtering i.e., the function is very large at low frequency and decreases as the frequency increases.

CIRCUIT DIAGRAM: -



INTEGRATED CIRCUIT

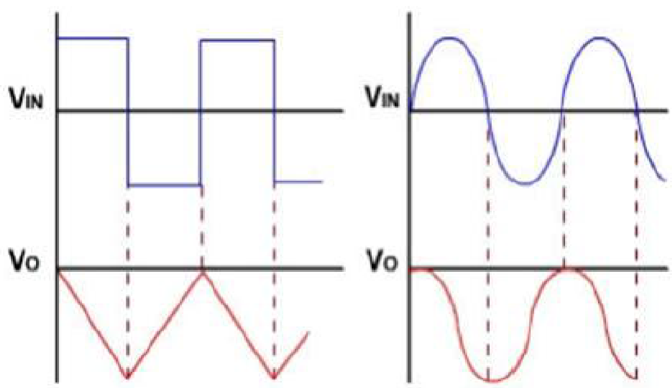
PROCEDURE: -

(1) Connect the circuit according to the circuit diagram.
(2) Apply square wave to the input terminal of integrator circuit.
(3) Set the input voltage at 1V peak to peak and frequency at 1 KHz.
(4) Note down the input and output waveform.
(5) Draw the waveform on graph paper.

OBSERVATION TABLE: -

S.NO	I/P Voltage Vin	O/P Voltage Vo	Frequency in KHz.	Gain=20log Vo/ Vin

GRAPH:-



PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DISCUSSION: - What is the application of integrator?

RESULT: - Waveforms shows Integrator acts as low pass filter.

EXPERIMENT NO. 7

AIM: - Design & verify the operations of op amp adder and subtractor circuit.

APPARATUS REQUIRED:- CRO, function generator, ± 12V supply, breadboard, 741 IC, resistors 1KΩ (7 pieces), and Connecting leads.

THEORY: -

Adder: - If the input to the inverting amplifier is increased, the resulting circuit is known as Adder. Output is a linear summation of number of input signals. Each input signal produces a component of the output signal that is completely independent of the other input signal. When there are two inputs i.e.

$$Vo = -(V1 + V2)$$

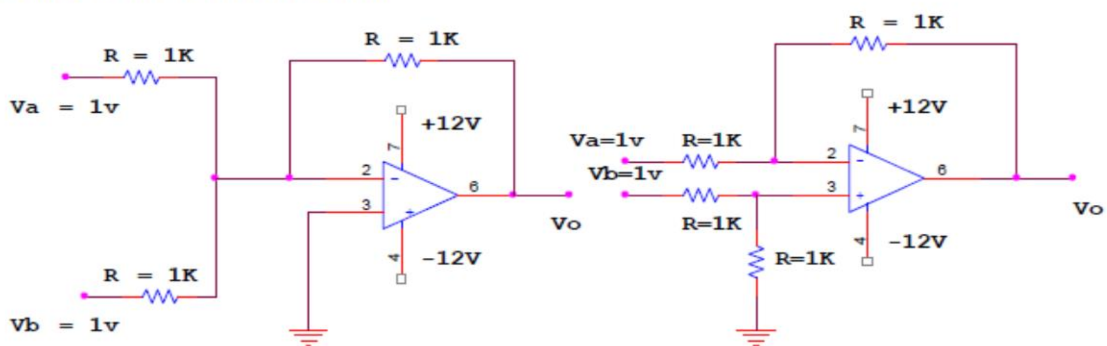
This is the inverted algebraic sum of all the inputs. If we connect the inputs to non-inverting, terminal then the adder is non-inverting adder.

Subtractor: - A circuit that finds the difference between two signals is called a subtractor. The two inputs are applied at the inverting & non-inverting terminal of op-amp. If all external resistance are equal in value, so the gain of the amplifier is equal to 1.The output voltages of the differential amplifier with a gain of unity is,

$$Vo = -R \backslash R(Va-Vb)$$

$$Vo = (Vb-Va)$$

CIRCUIT DIAGRAM: -



ADDER

SUBTRACTOR

PROCEDURE: -

(1) Apply two different sine waves signal to the input of the adder and subtractor.

(2) Give the input amplitude of 5v peak to peak and frequency of 1 kHz.

(3) Verify the output on CRO.

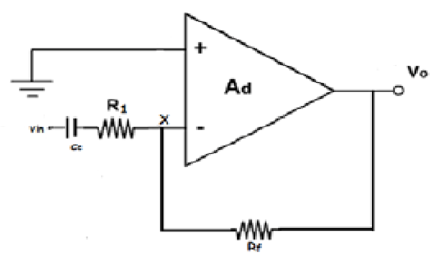
EXPERIMENT NO.8

AIM:-Plot frequency response of ac coupled amplifier using opamp 741 and study the effect of negative feedback on the bandwidth and gain of the amplifier.

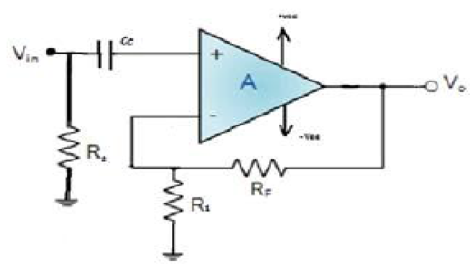
APPARATUS REQUIRED: - CRO, Function Generator, Bread Board, 741 IC, ± 12V supply, resistors1KΩ, 10KΩ, capacitors and connecting leads.

THEORY:-Inverting and non inverting amplifier respond to both ac and dc. For studying only ac frequency response, or if the ac input signal is superimposed on some dc level, it is necessary to block dc component, by using ac coupling capacitor. Two types of AC amplifier:-

1) Inverting
2) Non inverting



Inverting AC amplifier



Non-Inverting AC amplifier

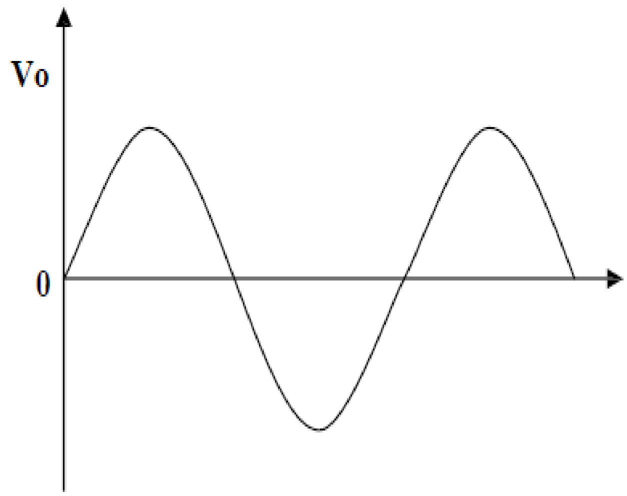
PROCEDURE: -

(1) Set the input voltage at 1V peak to peak and frequency at 1 KHz.
(2) Varying the frequency of the input signal from 10Hz to1MHz.
(3) Measure the output signal amplitude.
(4) Draw the frequency response characteristics of AC coupled amplifier.

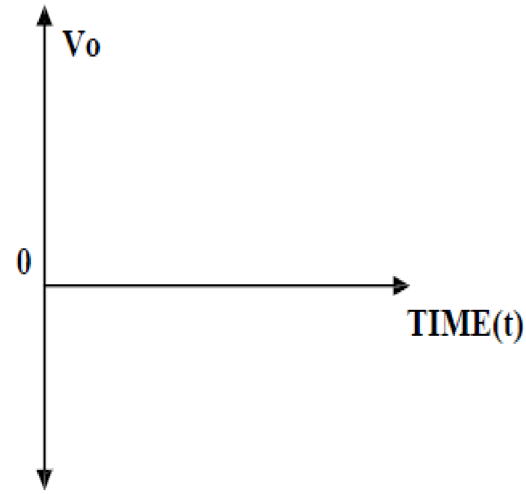
OBSERVATION TABLE:-

S.NO.	FREQUENCY (Hz)	OUTPUT VOLTAGE (Vout)	GAIN (Vout/ Vin) IN dB

WAVE FORM: -



ADDER



SUBTRACTOR

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
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3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DICUSSION:-Name the areas where adder and sub tractor circuits are used.

RESULT: - Output is a true replica of the subtraction values of the two inputs and addition of two input values.

EXPERIMENT NO.9

AIM: -Study of IC 555 as astable and monostable multivibrator.

APPARATUS REQUIRED: - IC 555

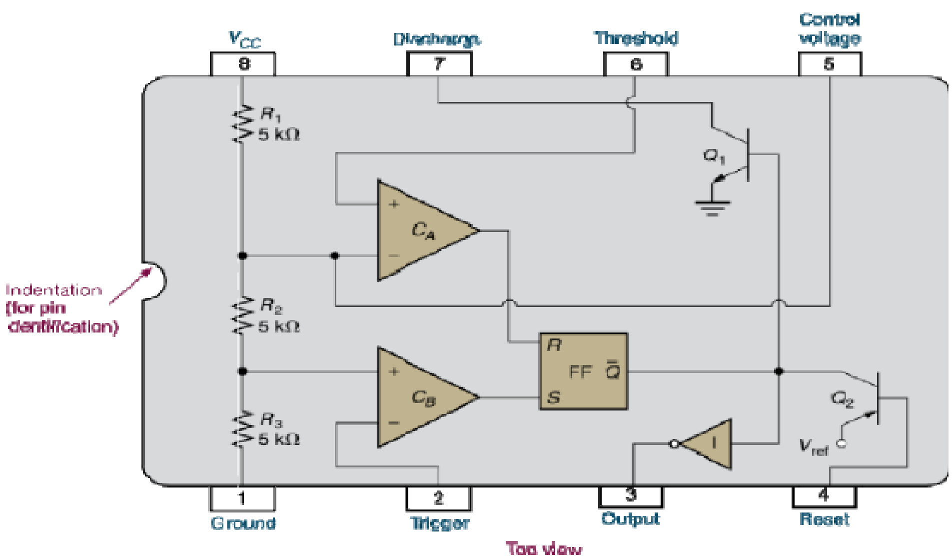
THEORY: -

555 timer – An 8-pin IC designed for use in a variety of switching applications.
Multivibrator – A circuit designed to have zero, one, or two stable output states. There are three types of multivibrators:

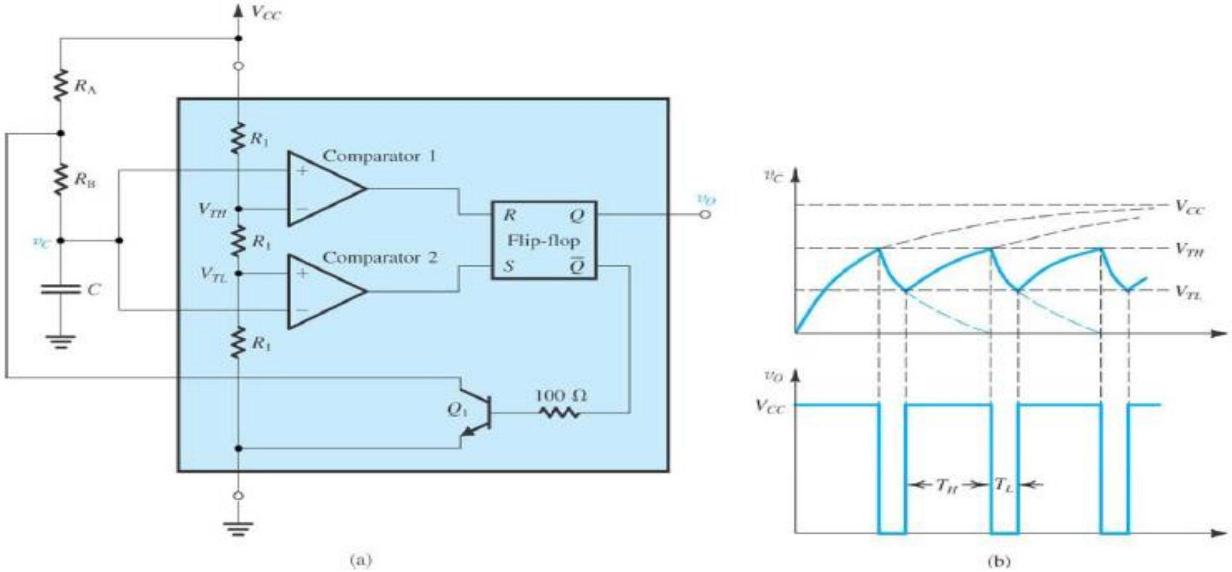
- ¾ Astable (or Free-Running Multivibrator)
- ¾ Monostable (or One-Shot)
- ¾ Bistable (or Flip-Flop)

Astable multivibrator – A switching circuit that has no stable output state. The astable multivibrator is a rectangular wave oscillator. Also referred to as a free-running multivibrator.
Monostable multivibrator – A switching circuit with one stable output state. Also referred to as a one-shot. The one-shot produces a single output pulse when it receives a valid input trigger signal.
Bistable multivibrator – A switching circuit with two stable output states. Also referred to as a flip-flop. The output changes state when it receives a valid input trigger signal, and remains in that state until another valid trigger signal is received.

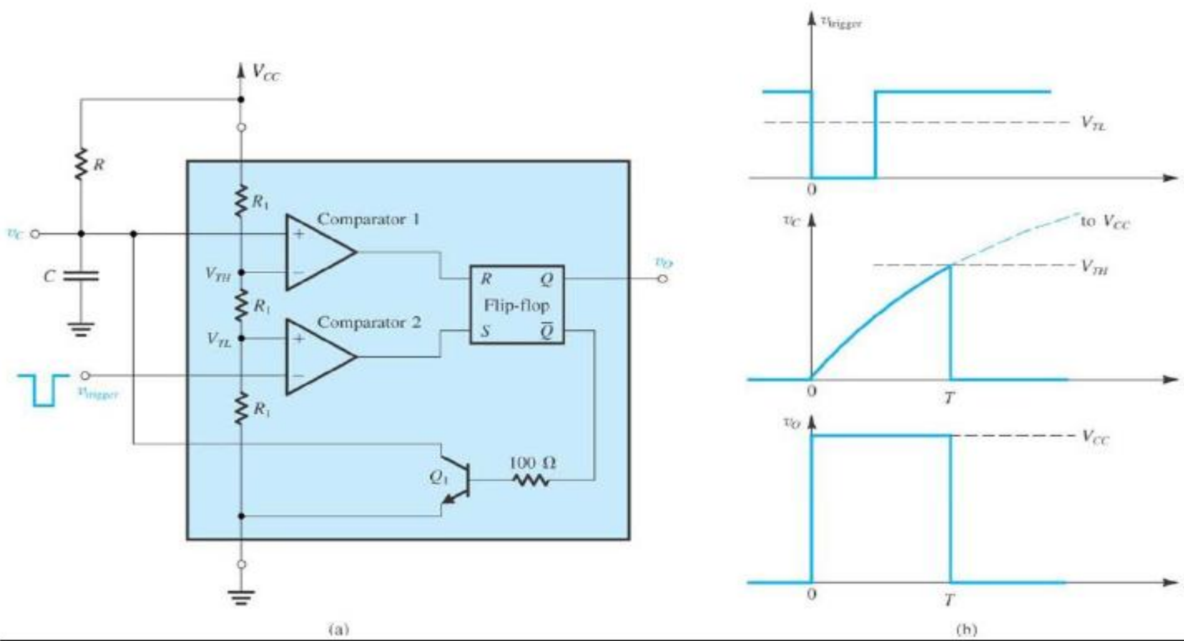
PIN CONFIGURATION OF IC 555:-



CIRCUIT DIAGRAM & WAVEFORM OF ASTABLE MULTIVIBRATOR: -



CIRCUIT DIAGRAM & WAVEFORM OF MONOSTABLE MULTIVIBRATOR: -



RESULT: - Astable and monostable multivibrator has been studied.

EXPERIMENT NO.10

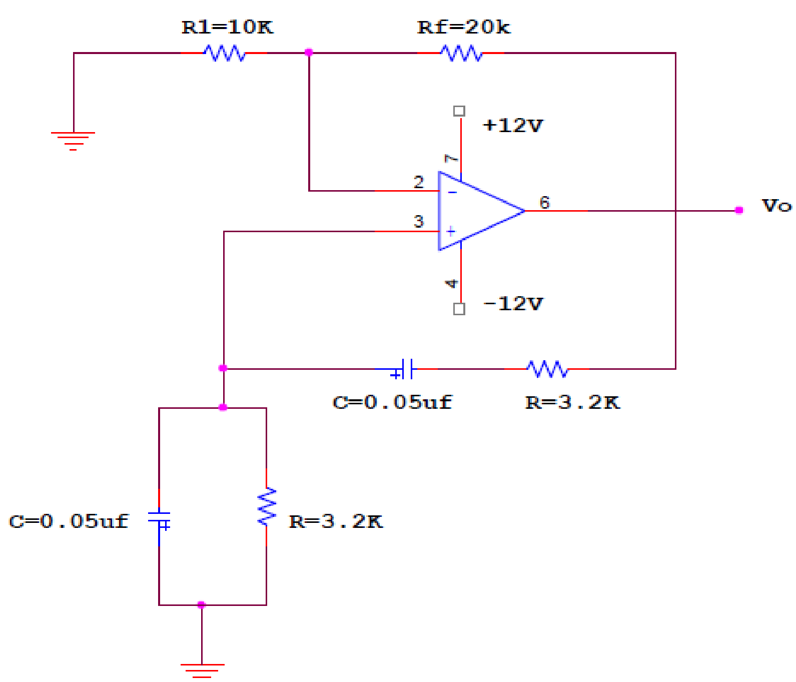
AIM: - Design and realize using op amp741, wein bridge oscillator.

APPARATUS REQUIRED:- Bread board, CRO, ± 12V power supply, Resistors 10KΩ, 20KΩ, 3.2KΩ, 0.05μf, and connecting leads.

THEORY: - In Wein bridge oscillator, Wein bridge circuit are connected between amplifier input and output terminal. The bridge have a series RC network in one arm and a Parallel RC network in adjoining arm, on the remaining two arms of bridge, resistor R_1 and R_f are connected. The phase angle criterion for oscillator is that the total phase shift around the circuit must be 0°.This condition occurs only when the bridge is balanced, i.e. at resonance. The frequency of oscillation f_0 is exactly the resonant frequency of the balanced wein bridge and is given by

$$f_0 = 1/2\pi RC = 0.159/RC$$

CIRCUIT DIAGRAM:-

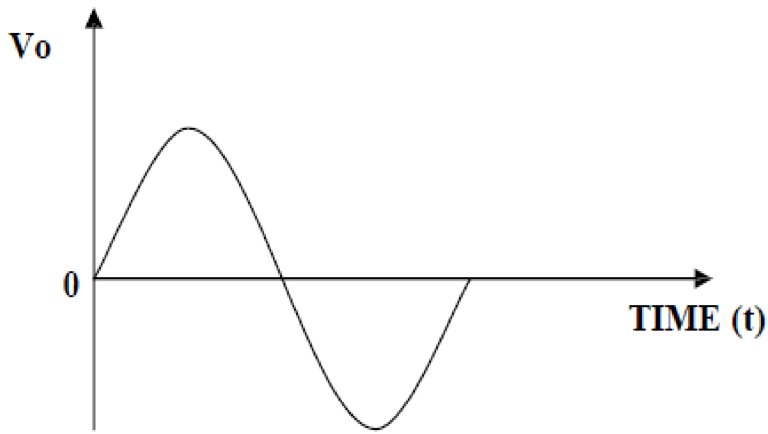


WEIN BRIDGE OSCILLATOR

PROCEDURE: -

(1) Connect the circuit as per the circuit diagram.
(2) Switch 'on' the power supply.
(3) Output of the circuit is shown on CRO.

WAVE FORM: -



PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply?
2. Before connecting the power supply plug into socket, ensure power supply should be switched off
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DICUSSION: - Wein bridge oscillator generates sine wave forms.

RESULT: - Sine wave is generated on CRO.

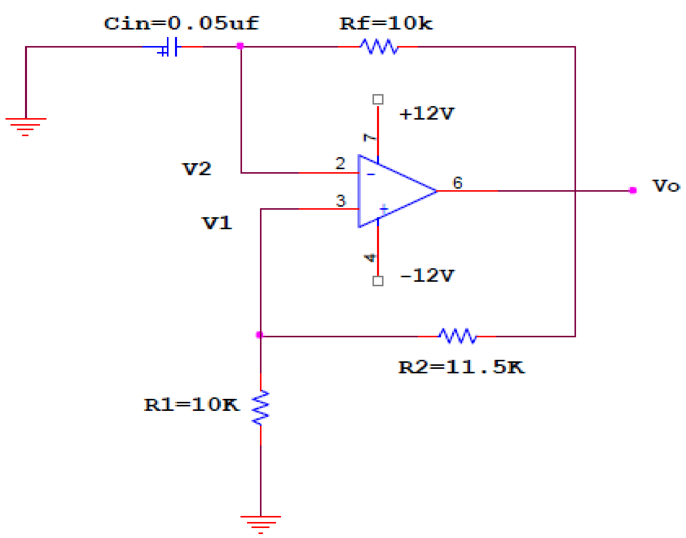
EXPERIMENT NO.11

AIM: - To design and realize using op amp741, square wave generator.

APPARATUS REQUIRED: - Power supply, CRO, Function Generator, Connecting Leads, Breadboard, 741 IC, Resistance (10KΩ, 11.5KΩ), 0.05µf capacitor.

THEORY: - Square Waves are generated when the Op-Amp is forced to operate in the saturation region. That is, the output of the op-amp is forced to swing respectively between $+V_{sat.}$ and $-V_{sat}$. resulting in the generation of square wave. The square wave generator is also called a free- running or astable multivibrator. Assuming the voltage across capacitor C is zero at the instant the d.c Supply voltage at +Vcc and $-V_{EE}$ are applied. Initially the capacitance C acts, as a short circuit. The gain of the Op-Amp is very large hence V_1 drives the output of the Op-Amp to its saturation.

CIRCUIT DIAGRAM: -

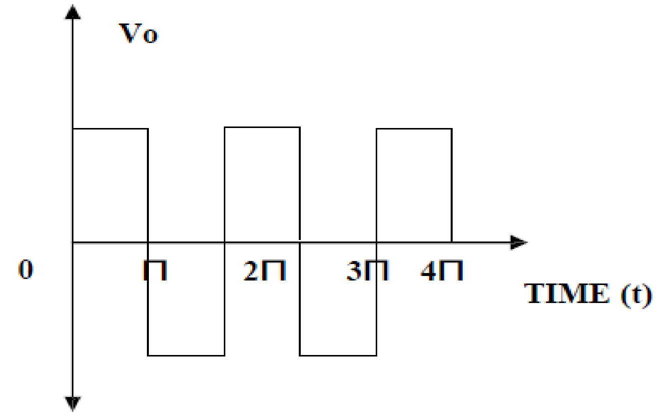


SQUARE WAVE GENERATOR

PROCEDURE: -

(1) Connect the circuit as shown in figure Switch 'ON' the supply.
(2) No. Input signal is feed from the generator. It is self-generating.
(3) Frequency can be varied by changing RC combination.
(4) Output is obtained at Pin 6 of op-Amp.

WAVE FORM:



PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DICUSSION:-What is the application of squire wave generator.

RESULT: - Squire Wave is obtained on CRO.

EXEPERIMENT NO.12

AIM: - To design and realize using op amp 741, logarithmic amplifier & VCCS.

APPARATUS REQUIRED: - CRO, function generator, breadboard, resistor 10KΩ, 1 KΩ and 12V supply, diode IN 4007 and connecting leads.

THEORY OF LOGARITHMIC AMPLIFIER: - In fig., there is an op-amp with the feedback resister R replaced by the diode D. Logarithmic amplifier is used when it is desired to have the output voltage proportional to the logarithm of the input voltage. We know from the volt-ampere diode characteristic

If $I = I_o\ (e^{Vf/nVt} - 1)$

$I = I_o e^{Vf/nVt}$

Provided that $V_f/nV_t >> 1$ or $If >> Io$. Hence

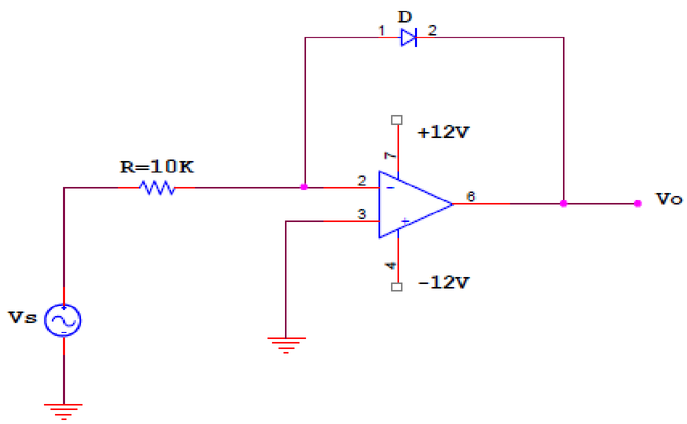
$V_f = nVt\ (I_n\ I_f - I_n\ I_o)$ --------- (1)

Since $I_f = I_s = V_s/R$ due to the virtual ground at the amplifier input, then

$V_o = - V_f = - nVt\ (I_n\ V_s/R - I_n\ I_o)$ ------------ (2)

From Eq^n. (2) the output voltage V_o is temperature dependent due to the scale factor nV_t and to the saturation current Io.

CIRCUIT DIAGRAM:-



LOGARITHMIC AMPLIFIER

PROCEDURE: -

(1) Connect the circuit on the breadboard as per circuit diagram.
(2) Switch on the power supply and observe the output waveform on the CRO.

THEORY OF VCCS (VOLTAGE CONTROLLED CURRENT SOURCE):-

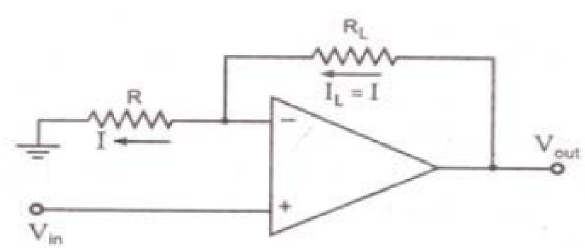
In many applications, one may have to convert a voltage signal to a proportional output current. A circuit which can perform this job is called a voltage –to- current converter. For this, there are two types of circuits possible:

V-I Converter with floating load
V-I Converter with grounded load

$I_L = I = V_{in} / R$

From above Eq. it is obvious that the output current I_L is independent of load resistance R_L and is proportional to the input voltage V_{in} . This is because of the virtual ground at the inverting input terminal of the op-amp. Such a circuit is employed in analog-to- digital converter (ADC).One good thing about the Op-amp. Voltage –to- current converter is that it can be driven by a voltage source which is itself not capable of supplying the load current called I_L. This is because the voltage source only has a drive a Non- inverting Op-amplifier, whose input impedance is very high. The load current itself is supplied by the Op-amplifier.

CIRCUIT DIAGRAM: -



Voltage-To-Current Converter

PROCEDURE: -

1. Connect the circuit as shown in figure Switch 'ON' the supply.
2. A voltage is given to the input pin.
3. Output is obtained at Pin 6 of op-Amp.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply
2. Before connecting the power supply plug into socket, ensure power supply should be switched off
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

DICUSSION: - How can we use logarithmic amplifier as a clipper circuit?
How VCCS is ideal circuit for low voltage dc and ac voltmeters?

RESULT: -Output is the negative of the log of an input.
In VCCS, load current depends upon the input voltage Vin and resistor R.

EXPERIMENT NO: 13

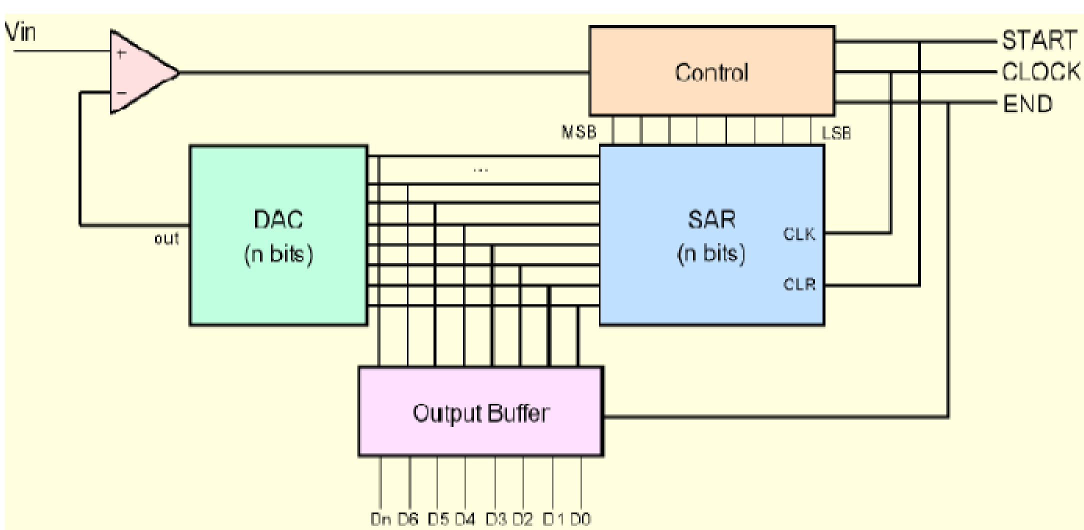
AIM: -Study of 8-bit monolithic Analog to digital converter.

APPARATUS REQUIRED: - ST2601 with power supply cord, Connecting Cords

THEORY: - Successive approximation ADC uses one or a few comparators, operated iteratively, to yield high accuracy conversion with far fewer components than flash conversion.

A/D converter using successive approximation technique effectively performs a binary search in a digital analog look up table and using a digital to analog converter (DAC) and comparator circuit. Successive approximation converters also allow higher resolutions but tend to be slower since they usually require N cycles to produce the answer. Successive approximation ADC operates at much slower conversion rates than flash ADC. Sub ranging analog to digital converters provide an intermediate compromise between flash ADCs and successive approximation ADCs. Sub ranging analog to digital converters typically use a low resolution flash quantizer during a first or coarse pass to convert the analog input signal into the most significant bits (MSB) of its digital value. A digital to analog converter (DAC) then generates an analog version of the MSB word. The residue signal is sent through one or more fine passes to produce the lower significant bits of the input signal. The lower significant bits and the MSB word are then combined by digital error correcting circuitry to produce the desired digital output word. A switched capacitor analog to digital converter (ADC) operated according to successive approximation register technique comprises a plurality of weighted capacitors with associated switches and a local DAC. The capacitors are charged by a voltage sample of an analog signal to be converted. The voltage sample is compared with an analog signal generated by the local DAC.

CIRCUIT DIAGRAM:-



PROCEDURE:-

1. Connect supply to the trainer.
2. Make the connections as shown in figure.
   a. Connect the USB/ BOB to GND.
   b. Connect the DC output to V_i of Monolithic converter.
   c. Keep the DC potentiometer in counterclockwise direction.
   d. Keep the Auto /Manual switch in Auto position.
3. Switch ON the power supply.
4. Vary the DC potentiometer and observe the corresponding digital output on LEDs.
5. Now keep the Auto /Manual switch in Manual position.
6. Keep the Blank / Convert switch in Blank position
7. Vary the DC potentiometer
8. Set the switch to convert position, The LEDs will light forming a digital word which corresponds to the digital conversion of the analog voltage applied to the input.
9. Perform the same procedure with different DC voltages.
10. Now, connect the USB / BOB terminal to +5V and bipolar o/p to Vi. This gives Output voltage from +2.5V to -2.5V.
11. Keep the switch in Auto position.
12. Vary the Bipolar potentiometer from -2.5V to +2.5V, and note the corresponding digitized outputs.
13. Set the Auto / Manual switch to manuals position.
14. Keep the Blank / Convert switch to blank position.
15. Now to observe the conversion you have to throw the switch to convert position.
16. Perform the experiment with various DC inputs.

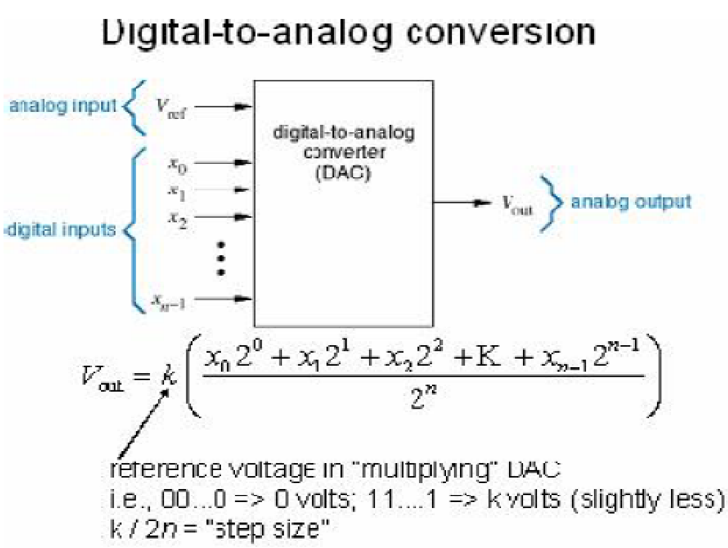
RESULTS:-According to applied input signal in form of DC level it provides the digital signals in 1 and 0 forms.

EXPERIMENT NO: 14

AIM: -Study of R-2R ladder network and 8-bit monolithic digital to analog converter.

APPARATUS REQUIRED: - ST2602 with power supply cord, Connecting Cords.

THEORY: -The digital to analog converters compose the devices transforming a digital word, binary encoded and generated for example by a computer, into a discrete analog signal, in the sense that to every input digital word a single output analog value corresponds.



PROCEDURE:-

1. Connect the power supply to the board.
2. Connect the D_0- D_3 of the logic switches to the corresponding jacks B_0-B_3 of the converter.
3. Set the switches S_0-S_3 to logic level 0.
4. Connect the V_{REF} socket to +5V.
5. Connect a Multi meter as voltmeter for DC, to the output V_0 of the converter.
6. Switch the logic switches in binary progression & measure & record the output voltage in correspondence of every combination of the input code.
7. With input code S_3 S_2 S_1 S_0 = 0000 the output voltage Vo has to be null: eventual little deviations against zero are due to the operational amplifier offset.
8. Switch off the power supply.

OBSERVATION TABLE: -

S0	S1	S2	S3	Vo(V)
0	0	0	0	
0	0	0	1	
0	0	1	1	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

RESULT:-As per the applied inputs through the switches then according to the reference voltage the output voltage is generated in analog form.