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DEPARTMENT OF PHYSICS

Project Report on

DESIGN INTEGRATOR AND DIFFERENTIATOR USING 741 OP-AMP

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विभागाध्यक्ष

भौतिक शास्त्र विभाग

शास. नवीन महा. हसौद

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Signature of the candidate

DECLARATION BY THE CANDIDATE

I hereby declare that the dissertation entitled "DESIGN AND REALIZE INTEGRA - TOR AND DIFFERENTIATOR AMPLIFIER USING 741 OPERATIONAL - AMPLIFIER" submitted by NEHA KASHYAP, Enrollment no: 2016016499 to GOVT. NAVEEN COLLEGE, HASOUD, DIST. - JANJGIR-CHAMPA (C.G), in fulfillment of the requirement for the award of the degree of master of science on physics is a record of bonafide research work carried out by me under the guidance of professor R.P Upadhyay during the course of the year 2021-2022. Further declare that the work reported in this dissertation has not been submitted, and other will not be submitted either in part or in full, for the award of any other degree or diploma of this university or of any other institute or university.

Date.............

Signature of the candidate

OUTLINES :-

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9. Discussions : Advantage , Disadvantage
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Introduction :-

Basically operational amplifier consists of a very high gain d.c. amplifire with Feed back having high input impedance a jow output impedance and acting as a differential amplifier . Operational amplifiers, Originally used to perform mathematical functions such as addition , integration differentiation etc. in analogue compaters are now put to a veriety of other uses e.g. as comparator pulse generater squre wave generator Schmitt trigger etc.

These days operational amplifier uses integrated eircait technology and is referred to as basic linear or analogue integrated circait.Ic Op AMH are widely used as they possess all the merits of monolithic integrated circuits .
e.g. Small size, low cost high relia bility ,low offset vollage and current and temperature tracking properties.

A typical Operational amplifirer,denoted as OP - AMP . It is a direct coupled high gain amplifire constituting one or more stage of differential amplifires and can be used to amplify both d.c. as well a.c. input signal.

Review Of Literature

1941:- A vacuam tube op amp. An op amp defined as a general - purpose Dc- coupled, high - gain inverting feedback amplifier, is first found in U.S. patent.

1947:- An op-amp with an explicit non- inverting input. In 1947 the op-amp was first formally defined and named in by John R. Ragazzini.

1949:- A chopper – Stabilized op-amp in 1949 Edwin A Goldberg desigened a chopper stabilized op-amp.

1953:- A commercially available op-amp in 1953 vaccume tube op-amp become commercially available with the release of the model K2 – W from George.A. philbrick.

1961 :-Commercially usefull by 1961. Solid – state discrete op-amp were being producted .

1962:- An op-amp in a potted module. By 1962 , several companies were producing modular

DESIGN INTEGRATOR AND DIFFERELTIATOR USING 741 OP-AMP

AIM :-

Design and realise integrator and differentiator using 741 Op-amp

MATERIALS AND METHODS :-

1 MATERIALS:-

Hardware used with technical specifications:-

Resistor

Capacitor

Transistor

Funtion generator

CRO(CATHOD RAY OSCILLOSCOPE)

RESISTORS:-

A resistor is a passive two terminals electrical component that implements electrical resistance as a circuit element. The current through a resistor is in direct proportion to the voltage across the resistor's terminals this relationship represented by ohm's law.

CAPACITORS:-

very widely Capacitor is a passive two terminals electrical component used to store energy in an electric field.the forms of practical capacities but all contain at least two electrical conductors separated by a dielectric.

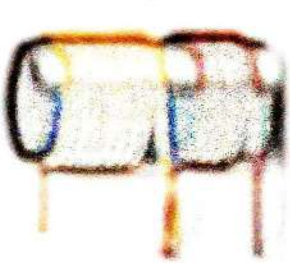
TRANSISTORS [BD 115]:-

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. it is composed of semiconductor materials usually with a least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power a transistor can amplify a signal. A transistor consists of two PN JUNCTION formed by sandwiching either p-type or n-type

semiconductor between a pair of opposite types. Accordingly there are NPN transistors and [illegible] transistor is composed of two n type

INDUCTORS

An inductor, also called a coil, choke or reactor, is a passive two-terminal electrical component that stores energy in a magnetic field when electric current flows through it.



III. CRO (CATHOD RAY OSCILLOSCOPE):-

An Oscilloscope previously called an oscillograph and informally known as a scope, CRO (for cathod ray oscilloscope)or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that allows observation of constantly varying signal voltages usually as a two dimensional graph of one or more electrical potential differences using the vertical or Y-axis plotted as a functions of time (horizontal or X-axis). Many signals can be converted to voltage, so and displayed as a steady picture. Many oscilloscopes (storage oscilloscopes) can also capture non repeating waveforms for a specified time shows a steady displays of the captures segment.[16]

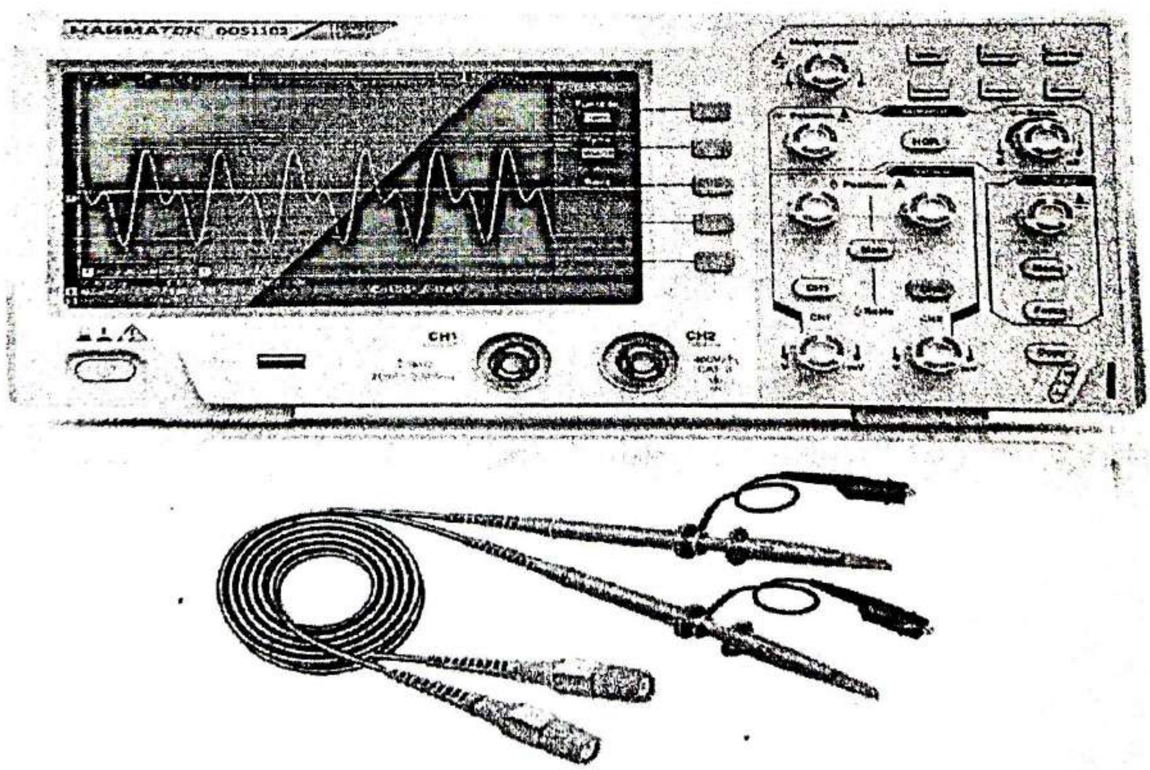


Fig. Digital Cathode Ray Oscilloscope(CRO)

Function Generator

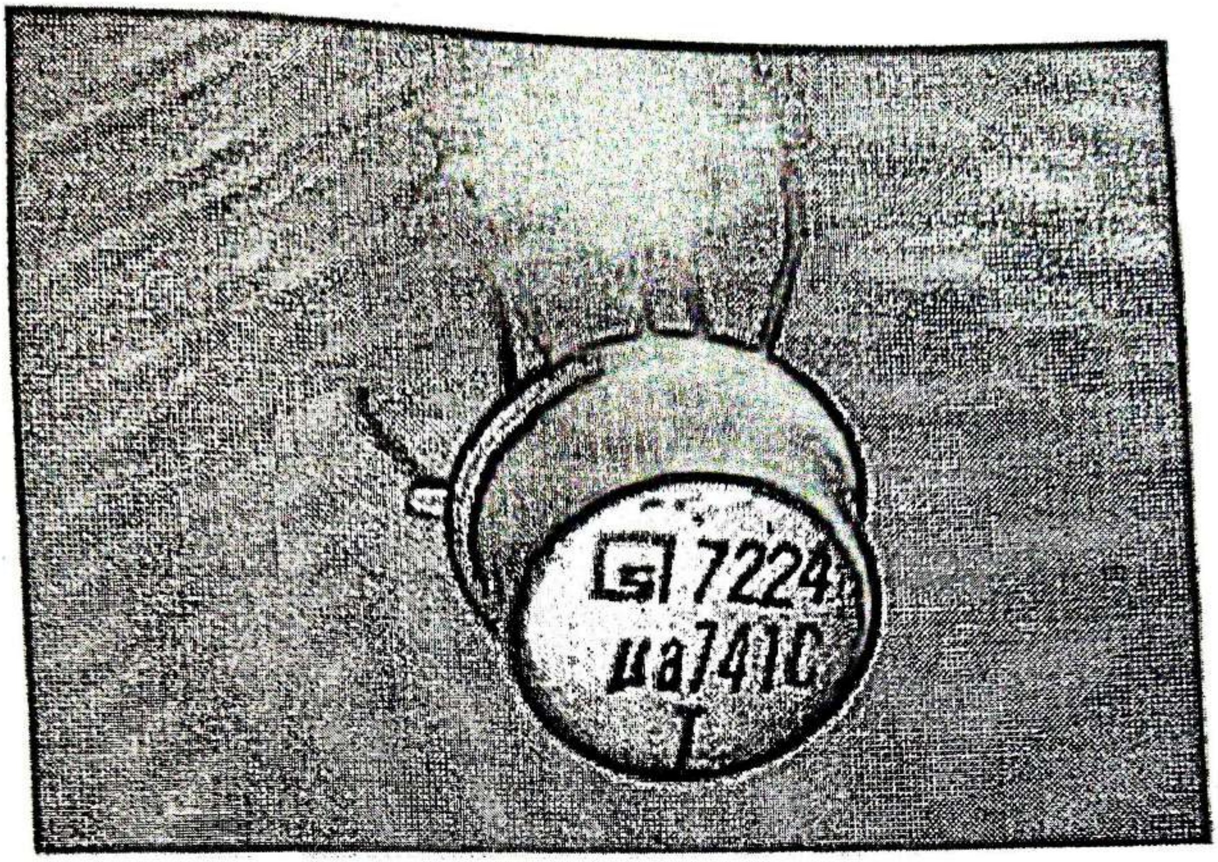
Introduction

A signal or function generator is a device that can produce various patterns of voltage at a variety of frequencies and amplitudes. A common use is to test the response of circuits to a known input signal. Most function generators allow you to generate sine, square or triangular AC function signals. You can view the signals produced by connecting the signal generator, using a BNC-Banana adapter, to an oscilloscope.

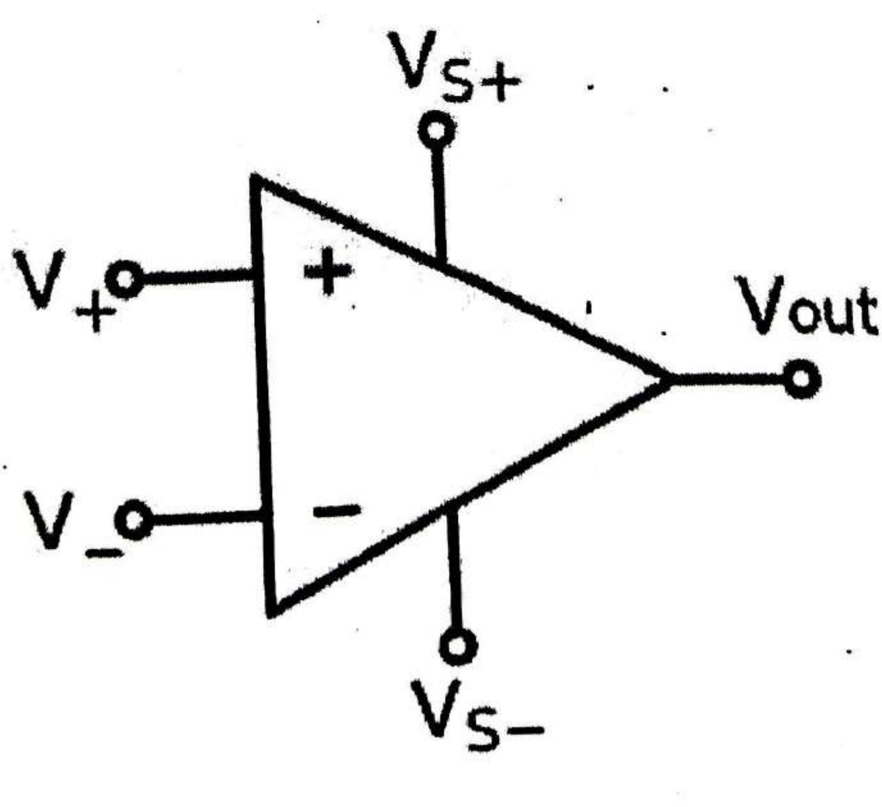
Op-Amp 741 IC

The 741 IC op-amp looks like a chip and it is a general purpose op amp. The 741IC op amp diagram is shown below that consists of 8 pins. The most important pins are pin-2, pin-3 and pin-6 because pin 2 and 3 represent inverting and non-inverting terminals where pin6 represents voltage out. The triangular diagram in the op-amp represents an Op-Amp integrated circuit. The modern version of the IC is represented by the famous 741 op-amp. Op-amp is mainly used to perform mathematical operations in various electronic circuits.It is the common feature of analog electronics. 741 IC is built from various transistor stages which commonly contain a differential i/p stage, a push-pull o/p stage and an intermediate gain stage. The differential op-amps comprises of a matched pair of FETs or bipolar junction transistors.

Picture of Op-amp

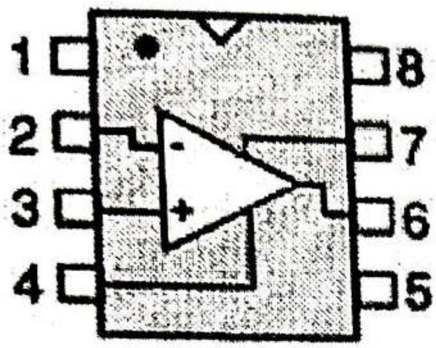


Symbol of Op-Amp

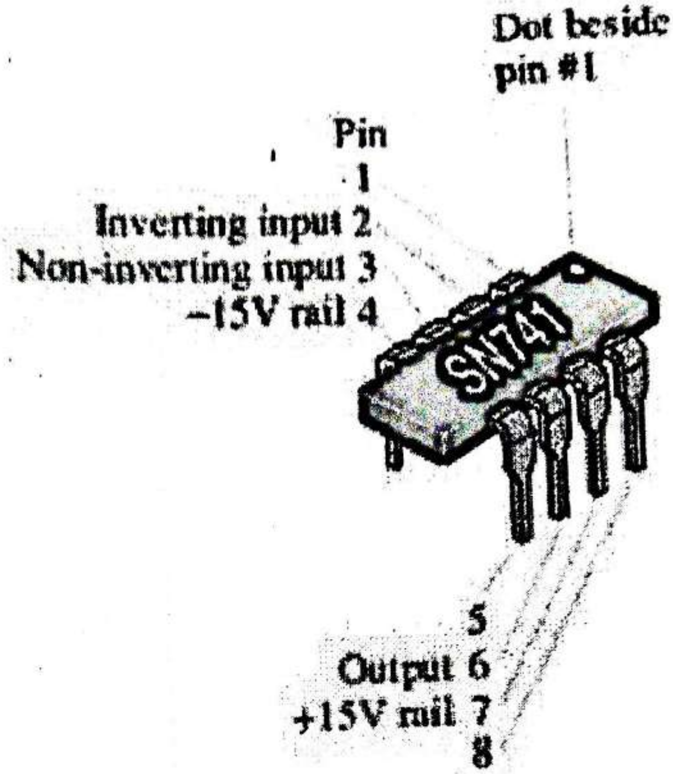


Packages of Op-Amp

741 Op Amp
8-pin DIP



Top view



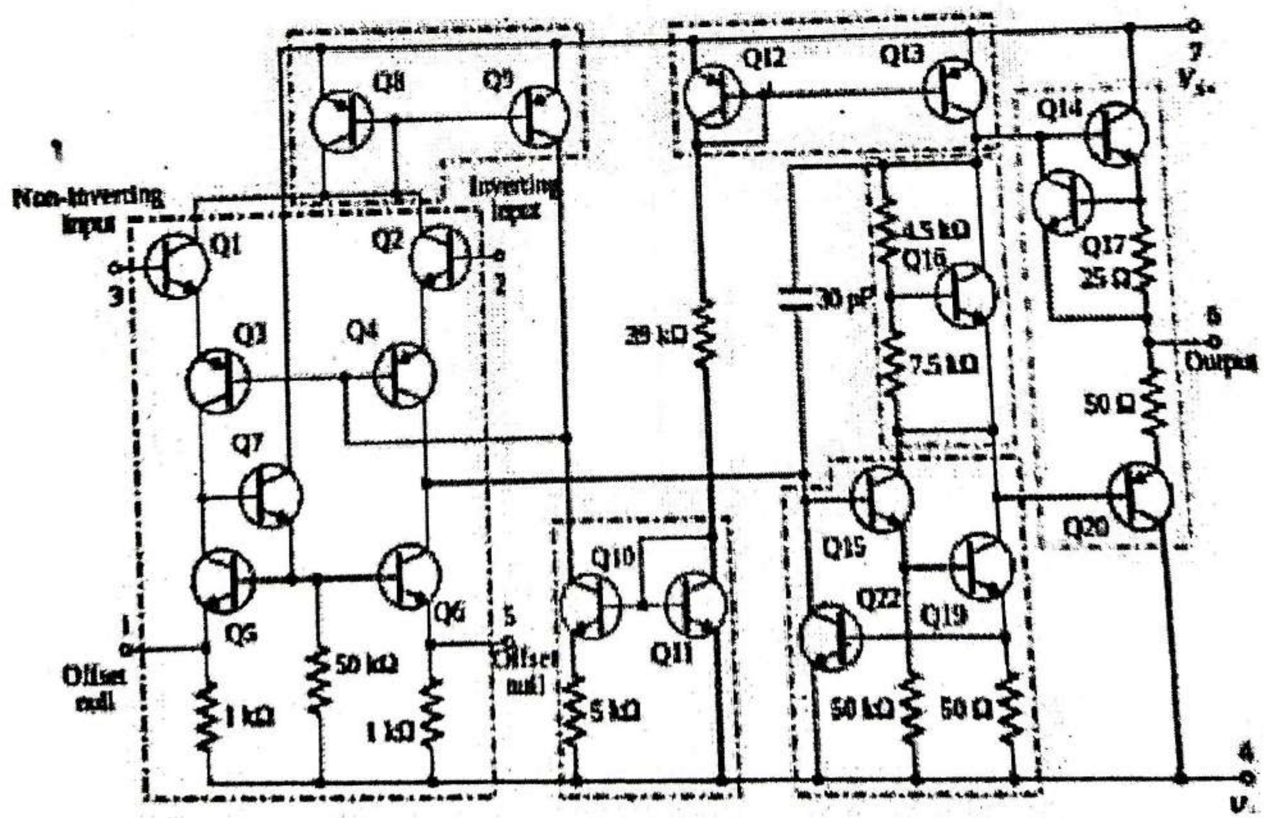
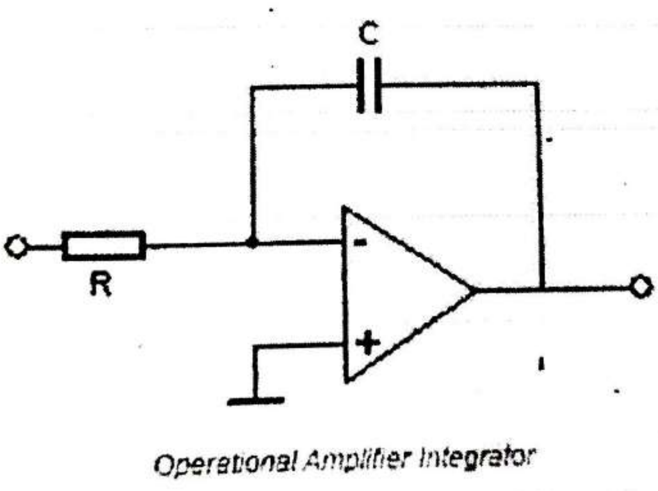


fig: A component-level diagram of the common 741 op-amp

An op-amp or operational amplifier is a linear device and extensively used in filtering, signal conditioning, or mainly used for performing mathematical operations such as addition, subtraction, differentiation, and integration. Basically, an op-amp uses external feedback components among the input as well as output terminals of op-amp like resistors and capacitors. These components will resolve the operation of the op-amp with good features like capacitive, resistive, etc. The amplifier can execute a variety of functions. An operational amplifier is a three terminal device includes two inputs and one output, where the inputs are inverting and non-inverting, and the outputs can be voltage or current.

INTEGRATED OP AMP

In most of the operational amplifier circuits, the feedback connection which is used is because of resistive in nature by a straight resistive line outlining as a minimum portion of the network. But for the op-amp integrator, the feedback will be provided by the capacitor among the input and output of the operational amplifier.



Operational Amplifier Integrator

As an op-amp integrator performs the function of mathematical integration. However, it can be used in analog computers. The operation of this circuit is, it generates an output which is proportional to the input voltage with time. So the output voltage will be determined with the primary output voltage at any time.

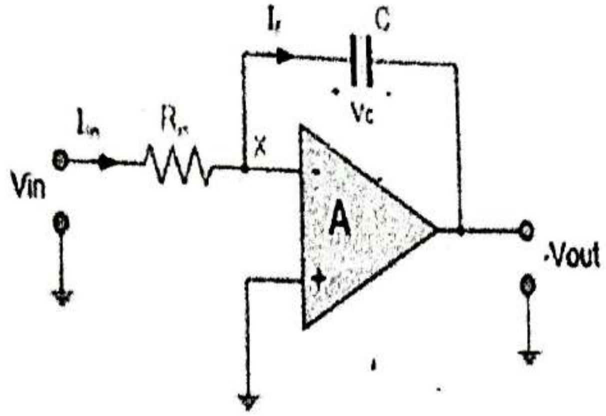


Figure 3

Since, the Output voltage is the potential difference accross capacitor.

$$V_C = \frac{Q}{C}$$

or,

$$V_C = V_X - V_{OUT} = -V_{OUT}$$

therefore $-\frac{dV_{out}}{dt} = \frac{1}{C} \times \frac{dQ}{dt}$

$\frac{dQ}{dt}$ is the current as the V_x is 0.

and input current can be written as

$$I_{IN} = \frac{(V_{IN} - 0)}{R_{IN}}$$

and current through capacitor (I_f) can be written as

$$I_f = C \times \frac{dV_{out}}{dt} = C \times \frac{1}{C} \times \frac{dQ}{dt} = \frac{dQ}{dt}$$

Assuming the ideal Op-amp its input impedance is infinite so no current pass through it.

$$I_{IN} = I_f = \frac{V_{IN}}{R_{IN}} = C \times \frac{dV_{out}}{dt}$$

therefor,

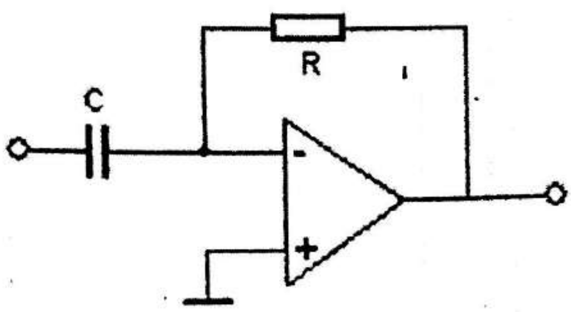
$$\frac{V_{IN}}{V_{OUT}} \times \frac{dt}{R_{IN} \times C} = 1$$

so,

$$V_{OUT} = -\frac{1}{R_{IN} \times C} \int V_{in}.dt$$

DIFFERENTIATOR OP AMP

In an op-amp differentiator circuit, the output voltage is directly proportional to the input voltage rate of change with respect to time, which means that a quick change of the input voltage signal, then the high o/p voltage will change in response. As the output of an op-amp differentiator circuit is proportional to the change in input. When the inputs of the differentiator circuit are standard waveforms like sine, square, triangular then the output waveforms will be very different.



Operational Amplifier Differentiator

If the input is square wave then there will be small spikes in other output waveforms. These spikes will be imperfect with the slope of the ends of the input waveform and maximum circuit output. If the input is triangular waveform then the output changes to a square waveform in the ow with the increasing and declining levels of the input waveform. If the input is sine wave from then it is changed to a cosine waveform which gives the signal with 90° phase shift, which is very useful in some situations.

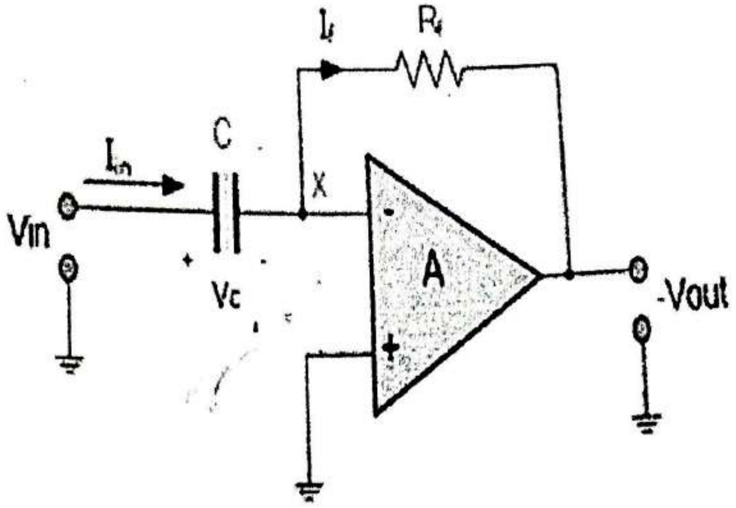


Figure: 3

Since, the node voltage V_x is 0

$$I_{IN} = I_f = -\frac{V_{OUT}}{R_f}$$

The charge accross capacitor is given by,

$$Q = C \times V_{IN}$$

The rate of change of charge is:

$$\frac{dQ}{dt} = C \times \frac{dV_{IN}}{dt}$$

and we know that $\frac{dQ}{dt}$ is capacitor current,

$$I_f = C \times \frac{dV_{IN}}{dt} = I_{IN}$$

Therefore from eq. 4.1 and 4.4,

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

PROCEDURE

INTEGRATOR

1. Set up the integrator circuit as shown in figure. Give a rectangular wave of ±5V (10V pp) and 1 kHz frequency at the input and observe the input and output simultaneously on CRO.
2. Vary the dc offset of the square wave input and observe the difference in the output waveform.
3. Repeat the experiment by feeding triangular wave and sine wave at the input and observe the output.

DIFFERENTIATOR

1. Set up the differentiator circuit as shown in figure. Give a rectangular wave of ±5V (10V pp) and 1 kHz frequency at the input and observe the input and output simultaneously on CRO.
2. Repeat the experiment by feeding triangular wave and sine wave at the input and observe the output.

WAVEFORMS

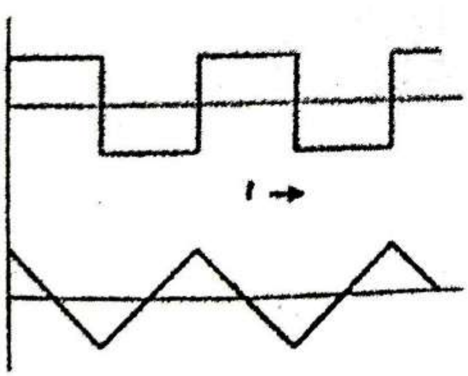


Fig 3. Integrator output

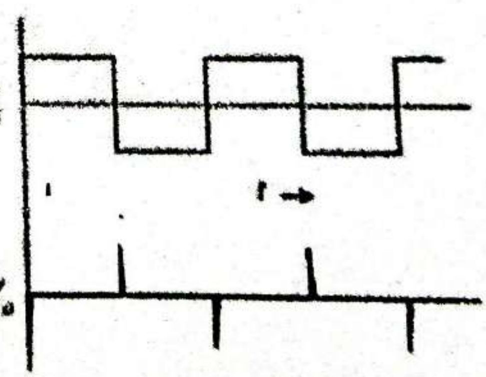


Fig 4. Differentiator output

RESULT -: The Integrater and Differentiator circuit design output waveform's have been studied.

Precautions

- Whenever you need to make a circuit change, turn the power supplies off. After making your change, check once more for possible wiring errors before reapplying power.
- To prevent damaging the op amp input stage, make sure the voltage you apply to either input terminal never exceeds +VCC and never goes below -VEE; this happens, for instance, if the power supplies are turned off while the input signal generator is still on. To avoid damaging the input stage, it is a good idea to use a series resistance, such as 10 kΩ, between the signal generator and the input pin.
- Don't connect anything to the op amp pins that are not in use.

Advantage

The great advantage of op-amp........

1. Op-amp has noise cancellation property
2. Op-amp can reduce external interference
3. The nature of these op-amp is linear
4. These op-amp help to increase CMMR (common mode rejection ratio) which further helps to avoid unwanted signal

Disadvantage

Some disadvantages of op-amp are..........

1. Complexity
2. Proper biasing needed

Applications

audio- and video-frequency preamplifiers and buffers
differential amplifiers
differentiators and integrators filters
precision rectifiers
precision peak detectors
voltage and current regulators
analog calculators
Analog-to-digital converters
Digital-to-analog converters
Voltage clamping
oscillators and waveform generators clipper
clamper (dc inserter or restorer)
LOG and ANTILOG amplifiers Most single, dual and quad op amps available have a standardized pin-out which permits one type to be substituted for another without wiring changes. A specific op amp may be chosen for its

open loop gain, bandwidth, noise performance, input impedance, power consumption, or a compromise between any of these factors.

Summary

1. The Op-amp as it is most commonly called can be an ideal amplifier with infinite gain and bandwidth when used in the open loop mode with typical DC gain of well over 1,00,000
2. The basic op-amp construction is of a 3-terminal device ,with 2-input and 1-output (excluding power connection)
3. An op-amp operators form either and dual positive (+V) and an corresponding negative (-V) supply , or they can operate from a single DC supply voltage
4. Two main laws associated with the op-amp are that it has an infinite input impedance (Z=infinite) resulting in "No current following into either of its two input" and zero input offset voltageV1=V2
5. An op-amp also has zero output impedance (Z=0) and etc.

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