UNIVERSITY OF SİVAS SCIENCE AND TECHNOLOGY

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MODULE PROJECT

INTEGRATOR OP-AMPS

**INTRODUCTION**

**What is the Operational Amplifiers?**

An operational amplifier (op-amp) is a type of electronic component used in circuits and devices. It is a versatile and important building block in analog electronics. Components of operational amplifiers:

Amplification: The main function of an op-amp is to amplify a voltage signal. It takes a small input voltage difference and produces a much larger output voltage.

Inputs and Output: An op-amp has two inputs and one output:

Inverter input (-): When the voltage at this input increases, the output voltage decreases.

Non-inverting input (+): When the voltage at this input increases, the output voltage also increases.

Output: Boosted voltage is available at this terminal.

Open Loop Gain: Op-amps have a very high open loop gain (usually in the range of 10,000 to 100,000 or more). This means that even a small voltage difference between inputs can produce a large output voltage.

Feedback: Op-amps are often used with feedback, which is a portion of the output signal fed back to the input. Feedback can be used to control gain and stabilize the performance of the circuit.

Ideal and Real Op-Amps: Theoretically, ideal op-amps have infinite gain, infinite input impedance (so they draw no current from the source), and zero output impedance (so they can supply any amount of current to the load). Real op-amps are very close to these characteristics but have some limitations.

Common Configurations:

Inverting Amplifier: The input signal is applied to the inverting input and the non-inverting input is connected to ground. The output signal is inverted and amplified.

Non-inverting Amplifier: The input signal is applied to the non-inverting input and the inverting input is connected to the output through a feedback loop. The output signal is amplified but not inverted.

Voltage Follower (Buffer): The output is connected directly to the inverting input and the input signal is applied to the non-inverting input. This configuration has a gain of 1 (output follows the input), but provides high input impedance and low output impedance.

Op-amps are used in various applications:

* Signal Amplification: Amplifying small signals to larger levels.
* Filters: Creating low-pass, high-pass, band-pass and band-stop filters.
* Oscillators: Produce periodic signals such as sine waves and square waves.
* Comparators: Compares two voltages and produces a high or low signal depending on which is greater.
* Integrators and Differentiators: Performing mathematical integration and differentiation of signals.

In summary, an op-amp is a highly versatile and widely used component for amplifying and switching signals in electronic circuits.

**What is the Integrator OP-AMPS?**

An integrator op-amp is designed to perform the mathematical operation of integration. In other words, it produces an output voltage proportional to the integral of the input voltage over time.

The integrator op-amp circuit typically consists of:

* An operational amplifier
* A resistor connected to the inverting input
* A capacitor connected between the inverter input and output
* Non-inverting input is usually connected to ground

**How does it work?**

Input Voltage (): The input voltage is applied to the inverting input of the op-amp through a resistor (R).

Feedback Loop: A capacitor (C) is connected to the feedback loop between the output and the inverter input.

Non-Inverting Input: The non-inverting input of the op-amp is typically connected to ground.

To the capacitor in the integrator op-amp:

Current Flow: When a voltage is applied to the input, current flows through the resistor to the capacitor.

Capacitor Charging: The capacitor charges over time and the voltage across the capacitor changes.Usage areas:

**ekran görüntüsü, diyagram içeren bir resim

Açıklama otomatik olarak oluşturuldu**As theorical calculation:

* According to op-amp’s, the voltages of the inverting input and non-inverting inputs are equal.

According to X point(from the kirchhoff law(KCL));

Also;

diyagram, metin, çizgi, ekran görüntüsü içeren bir resim

Açıklama otomatik olarak oluşturuldu

A Square Wave is a type of periodic waveform characterized by switching between two levels, typically high (Vhigh) and low (Vlow), with a fixed period (T). It has a duty cycle that is the ratio of pulse width to period.On a graph of voltage (Y-axis) versus time (X-axis), a square wave appears as a series of horizontal lines at Vhigh and Vlow.

An integrator circuit using an op-amp and a capacitor can convert a square wave into a triangular wave. Here's how:

Working principle:

* When a square wave (Vin) is applied to the integrator circuit, capacitor C integrates the input voltage over time.
* During the high phase of Vin (Vhigh), the capacitor charges through resistor R.
* During the low phase of Vin (Vlow), the capacitor discharges through resistor R.
* The output voltage Vout across capacitor C represents the time integral of Vin.
* From Square to Triangular Wave(Transformation Mechanism)

diyagram, metin, çizgi, plan içeren bir resim

Açıklama otomatik olarak oluşturuldu Which Op-Amp was used, what are its features?

741 Operational Amplifier (Op-amp): A classical op-amp commonly used in analog circuits. It operates on a dual power supply (typically ±15V) and has characteristics such as input impedance, output impedance, and frequency response that affect its performance in various applications.

Inverting Input (-) (Pin 2):

This is the input to which the inversion signal is applied. It is typically connected to the circuit node where the feedback components (such as resistors or capacitors) and the input signal source are connected.

Non-inverting Input (+) (Pin 3):

This is the input to which the non-inverting signal is applied. In non-inversion circuits it is usually connected directly to the input signal source. In some configurations, it can also be connected to ground through a resistor for biasing purposes (as in this example).

Output (Pin 6):

This is the output terminal of the op-amp. It provides an amplified or processed version of the input signal(s) depending on the circuit configuration and the feedback network connected to the op-amp.

Power Supply Pins (V+ and V-) (Pin 7 and 4 respectively):

These pins connect to the power supply voltage. In single-supply configurations, Pin 7 (V+) is typically connected to positive power supply voltage (+Vcc) and Pin 4 (V-) is connected to negative power supply voltage (-Vcc) or ground.

Offset Empty (Pin 1 and Pin 5):

These pins are used to adjust the DC offset of the output voltage. They are usually connected to each other and to ground via a capacitor or resistor-capacitor network to minimize DC offset errors in the op-amp.

CIRCUIT SIMULATION

The components of Circuit:

:10k ohm =10000 ohm

:10n Farad =10 Farad

Feedback Voltages=-9V/9V

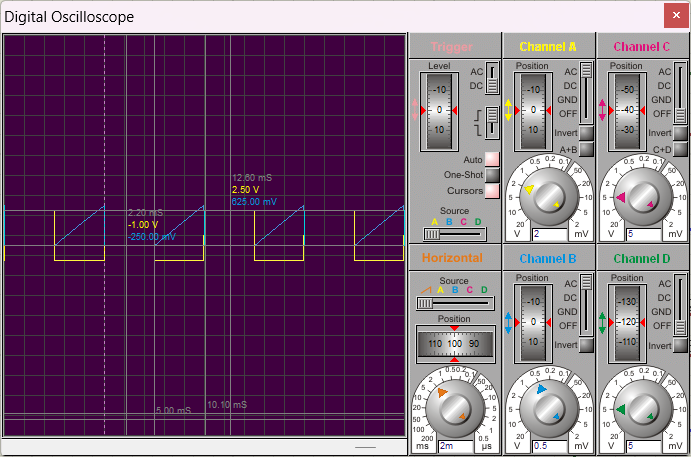
: Op-Amp 741 (the porpuse of op-amp’s;Integrator op-amp)

metin, diyagram, çizgi, plan içeren bir resim

Açıklama otomatik olarak oluşturulduFrequancy=100, amplitude=5

ekran görüntüsü, grafik yazılımı, multimedya yazılımı, diyagram içeren bir resim

Açıklama otomatik olarak oluşturuldu

ekran görüntüsü, grafik yazılımı, multimedya yazılımı, düzeltme, tashih içeren bir resim

Açıklama otomatik olarak oluşturuldu

**For the calculation part:**

R=10K ohm, C=1n Farad =

For(

For(

when t=0.01==0.25V

If you want to control values ​​with values;

250 (is same)

Gain: =750/-250=-3

**PROGRAMMING PART**

metin, ekran görüntüsü, yazı tipi, yazılım içeren bir resim

Açıklama otomatik olarak oluşturuldu

**A class named "Circuit" was created. Capacitor and resistor values ​​were defined as private to avoid external influence. Functions were created as public.**metin, ekran görüntüsü, yazı tipi, yazılım içeren bir resim

Açıklama otomatik olarak oluşturuldu

metin, ekran görüntüsü, ekran, görüntüleme, yazılım içeren bir resim

Açıklama otomatik olarak oluşturuldu

**In int main, values ​​were received from the user. The menu was opened and the user was asked to enter the desired action. It was valued.**

**Outputs:**

**Cmetin, ekran görüntüsü, yazılım, yazı tipi içeren bir resim

Açıklama otomatik olarak oluşturuldu**

**As can be seen, the same results were obtained as the calculation results.**

**AREAS OF USE IN DAILY LIFE**

**Waveform Integration: Integrators are used to create an output voltage proportional to the accumulated sum of the input voltage over time. This is useful in applications where the integral of a signal is required, such as analog computers and waveform shaping circuits.**

**Signal Processing: They are used in analog signal processing to perform functions such as averaging, time constant control, and phase shifting.**

**Filters: Along with resistors, integrators create high-pass and low-pass filters, depending on the configuration.**

**Mathematical Operations: Integrators are fundamental components of analog computing where they perform functions similar to mathematical integration.**

**RESOURCES**

<https://www.electronics-tutorials.ws/opamp/opamp_6.html>

<https://www.watelectronics.com/op-amp-integrator/>

<https://www.electronicshub.org/operational-amplifier-as-integrator/>