Experiment :

Date 12/11/24
Page No. 47

Experiment-8

Differentiator and Integrator using Op-Amp

 # Aim- To study Differentiator and integrator using op-amp.

 # Apparatus- Op-amp, Connecting wires, resistors, oscilloscope, capacitor

 # Theory

Op amp is a linear electronic device having three terminals, 2 high impedance input and one output terminal. Op-amp can perform multiple function when attached to different feedback combinations Generally, used as one voltage amplifier.

1) The Integrator

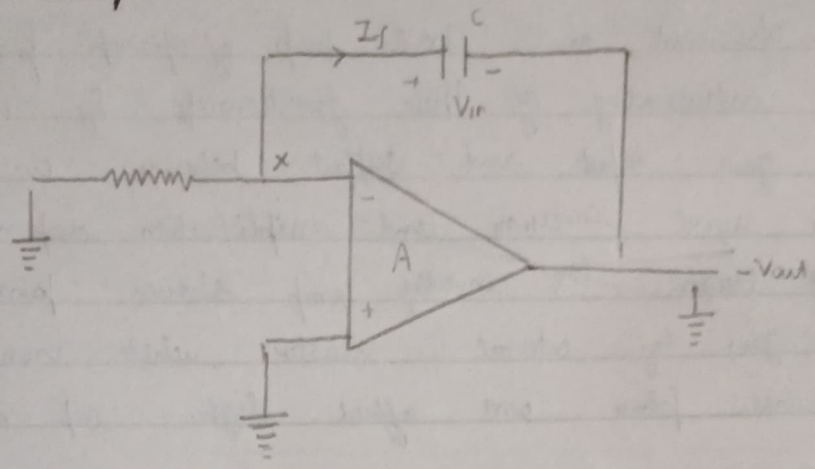
Its a circuit designed with op-amp so that it performs mathematical integration operation. Its output is proportional to amplitude and time duration of input. Feedback resistor replaced by capacitor. The results in ratio of capacitor impedance and input resistance increasing causing a linearly increasing amp output voltage that continues to increase until capacitor becomes fully charged.

$$V_c = \frac{Q}{C} \qquad I_{in} = \frac{V_{IN} - 0}{R_{IN}}$$

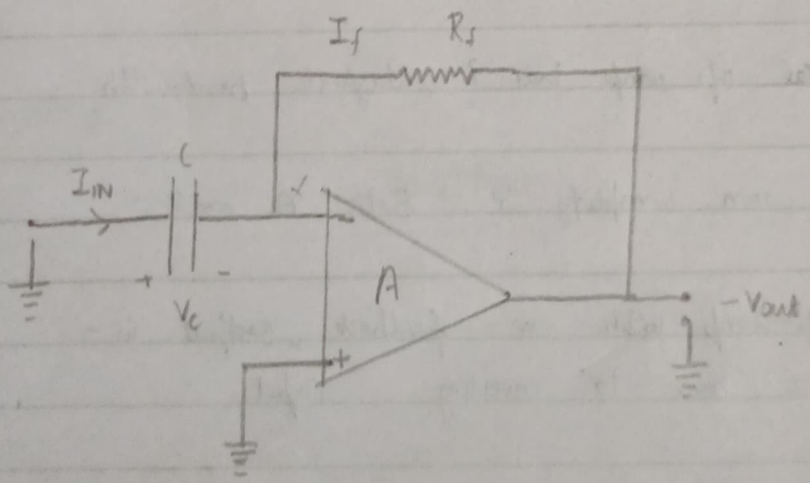
CLASSTIME

※ Diagram

(1) The Integrator



(2) The differentiator



Experiment :

Date

Page No.

$$I_f = C \times \frac{\partial V_{out}}{\partial t} = C \times \frac{1}{C} \times \frac{dQ}{dt} = \frac{dQ}{dt}$$

$$\text{So, } V_{out} = \frac{-1}{R_{IN} \times C} \int V_{in}\, dt$$

$$V_{out} = \frac{-1}{j \times \omega R_{IN} \times C} \times V_{IN}$$

2) The differentiator

In differentiation circuit, input is connected to inverting output of op-amp through C and negative feedback is applied to inverting input through R_f. Circuit provides mathematical differentiation operation and output is first derivative of input signal

$$I_{IN} = I_C = \frac{-V_{out}}{R_f}$$

$$I_f = C \times \frac{\partial V_{IN}}{\partial t} = I_{IN}$$

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

$$V_{out} = -R_f \times C \times \frac{\partial V_{IN}}{dt}$$

** Precaution :-

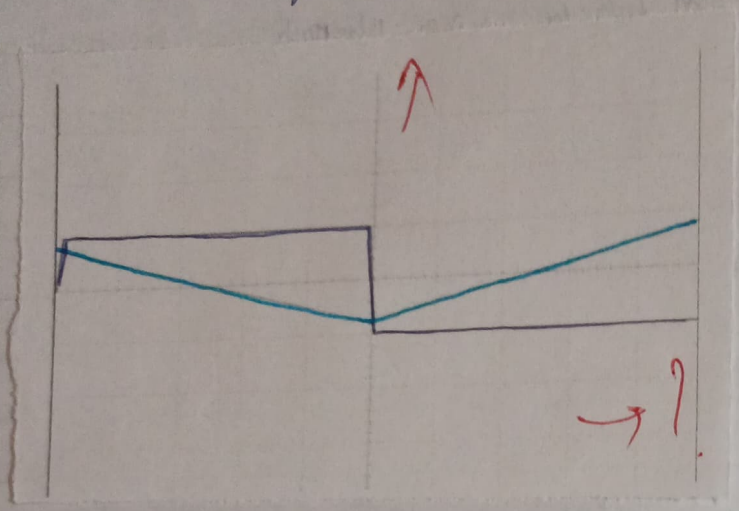
1) Verify the power supply voltage meter op-amp
2) Ensure proper grounding to prevent noise.
3) Avoid overheating by proper ventilation

CLASSTIME

[Light blue – Input waveform
Blue – Output waveform]

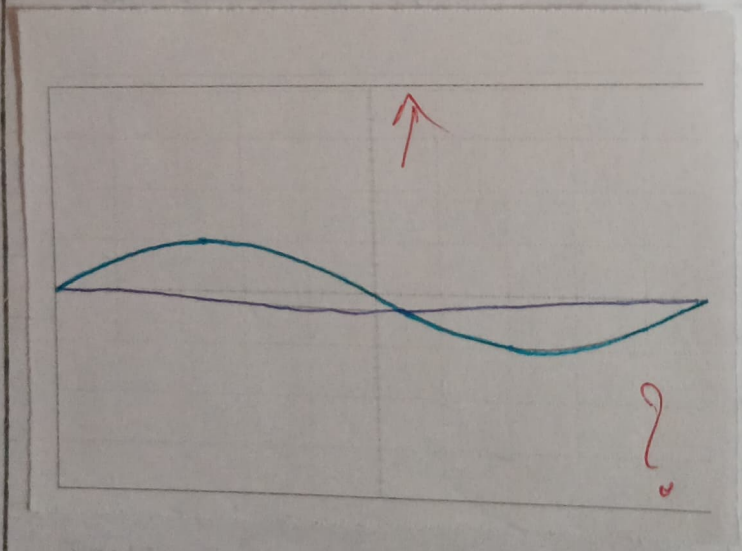
* GRAPH

① Integrator



(a) Square wave
freq = 3000Hz
Amplitude = 0.5 V

(b) Sine wave



freq = 3000Hz
Amplitude = 0.5V

Experiment :

Date

Page No.

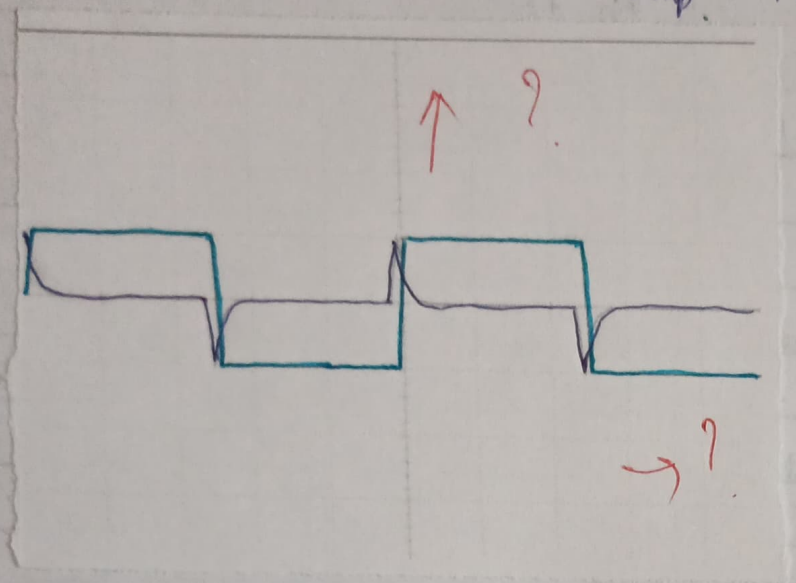
Conclusion

The experiment on differentiator and integrator circuits using op-amp demonstrated their functionality in signal processing. The differentiator does mathematical differentiation and integrator does mathematical integration. The practical implementation validated the theoretical concepts by observing expected phase shifts and waveform

GRAPHS

② Differentiator

a) Square wave → freq = 2000Hz
Amp = 1V



(b) Sine wave freq = 2000Hz
Amp = 1V