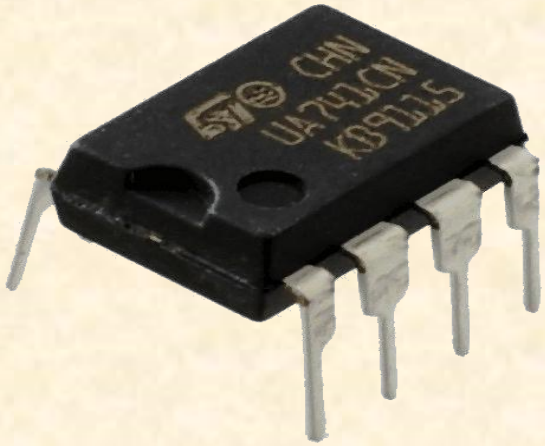
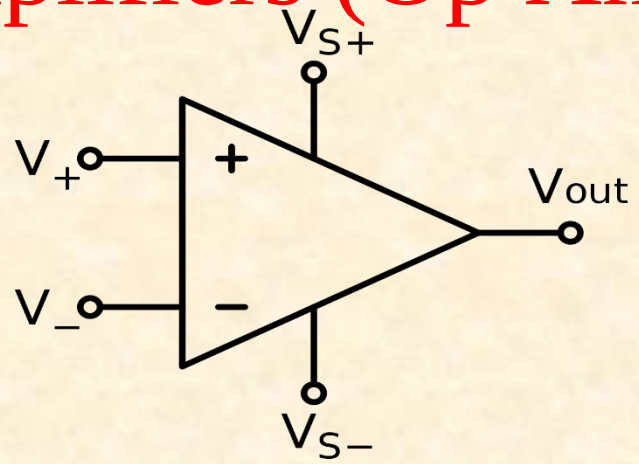
Operational Amplifiers (Op Amps)





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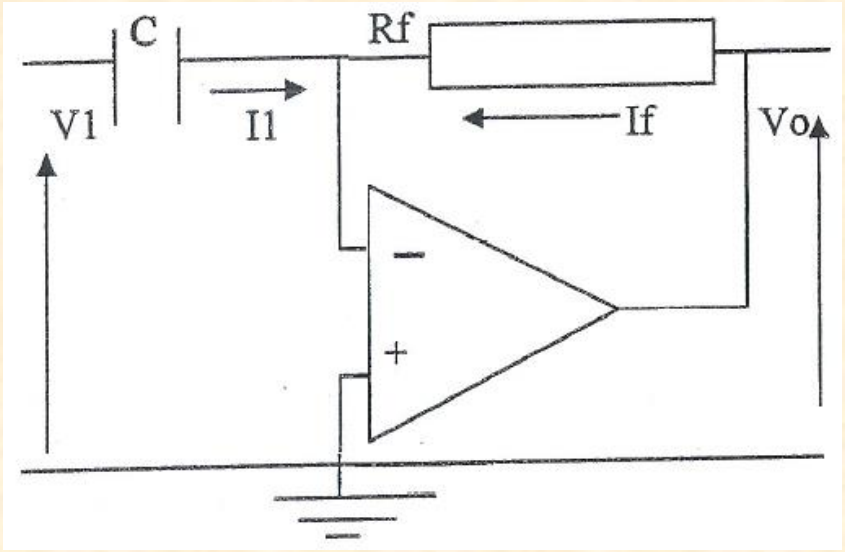
Outline

- The Differentiator
- Example
- The Integrator
- Example
- The Differential Op-amp
- OP-AMP Voltage follower

The Differentiator

The Differentiator:- it is one of inverting op-amp applications as shown in figure bellow.



Vo = If Rf (1)

If = - I1 (2)

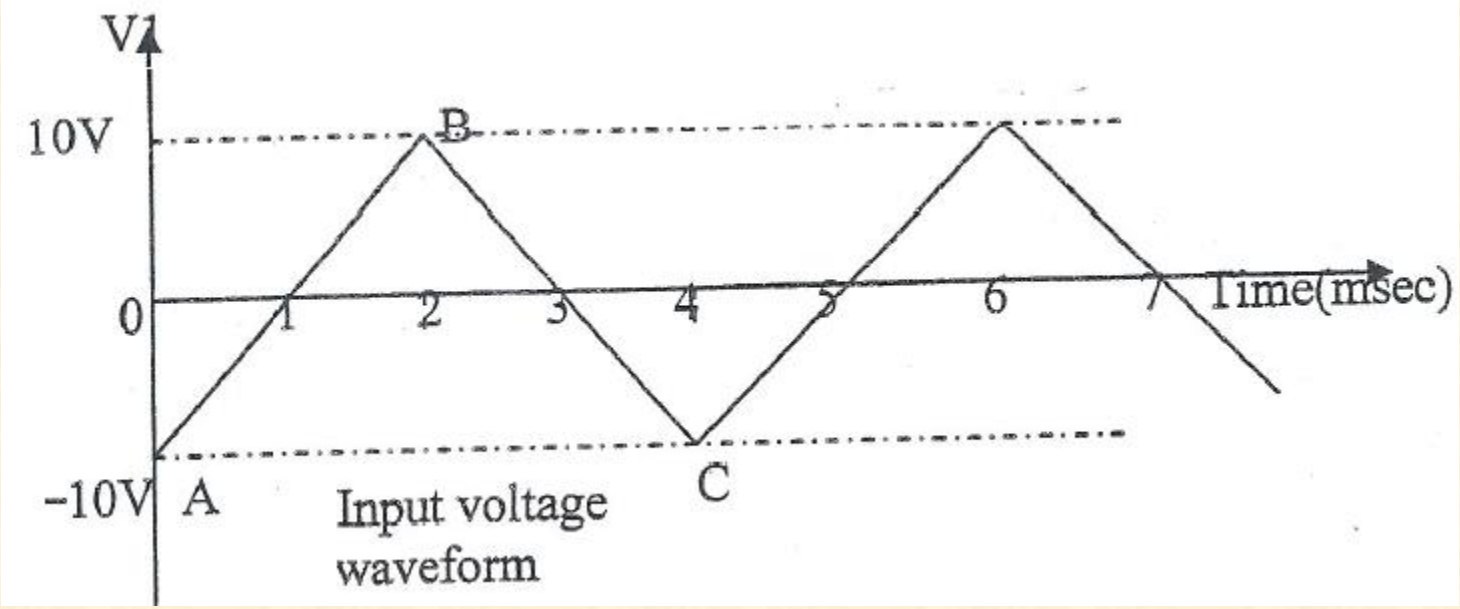
I1=C $\frac{dV1}{dt}$ (3)

Therefore:-

$Vo = -RfC\frac{dv1}{dt}$ (4)

Example

For the differentiator shown in figure above; if Rf= 10KΩ and t
value of the capacitor is 0.001μF, the input signal is given in Fig
bellow. Find the output voltage waveform.



Cont.

SOL.

من الشكل نلاحظ ان تغير الإشارة خطيا من A الى B وبقيمة ميل ثابتة تمثل المشتقة وتحسب كما يلي:-

$$\frac{dv1}{dt} = \frac{+10 - (-10)}{2 \times 10^{-3} - 0} = \frac{20}{2 \times 10^{-3}}$$

$$\frac{dv1}{dt} = 10^4 v/sec$$

And

$$Vo = -RfC\frac{dv1}{dt} = -(10^4) \times (0.001 \times 10^6) \times (10^4 V/s) = -0.1V$$

وبنفس الطريقة يحسب الميل لشكل موجة الدخل بين النقاط B و C وكمايلي:-

$$\frac{dv1}{dt} = \frac{-10 - (10)}{4 \times 10^{-3} - 2 \times 10^{-3}} = \frac{-20}{2 \times 10^{-3}}$$

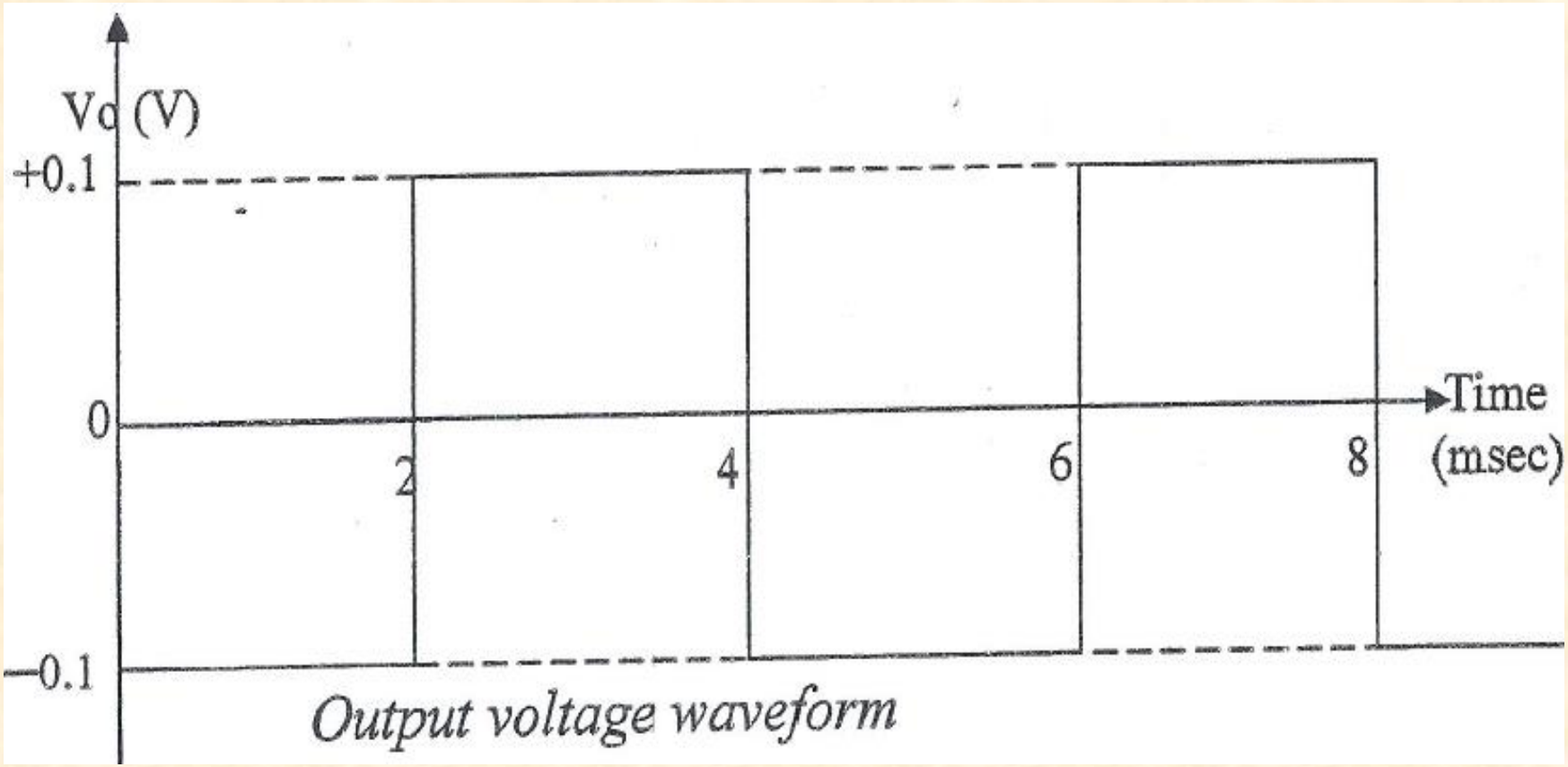
$$\frac{dv1}{dt} = -10^4 v/sec$$

And

$$Vo = -RfC\frac{dv1}{dt} = -(10^4) \times (0.001 \times 10^6) \times -(10^4 V/s) = 0.1V$$

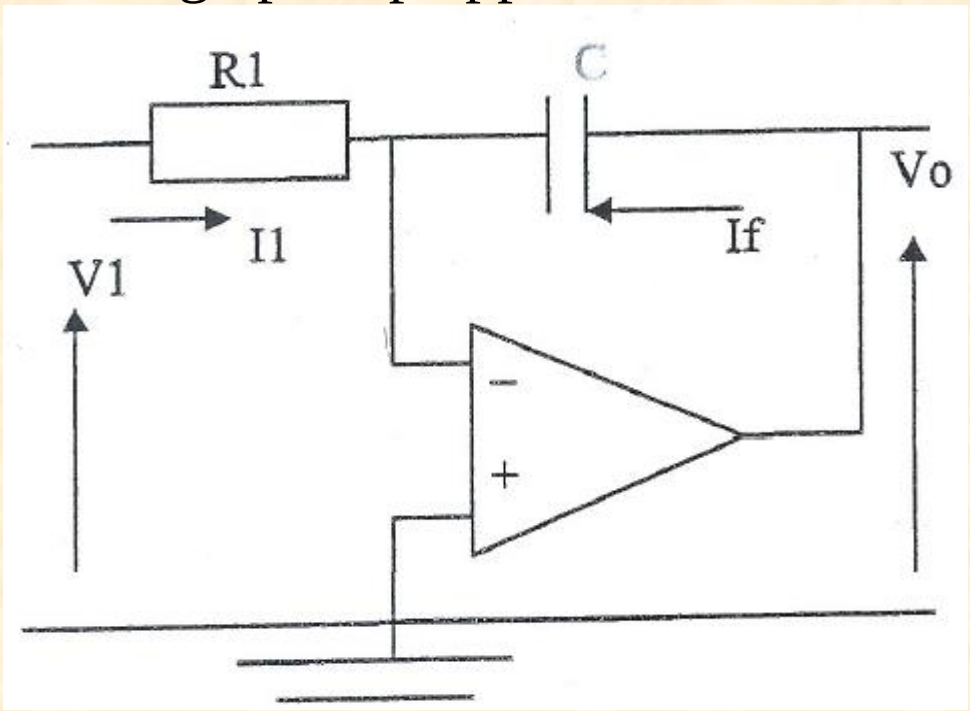
Cont.

وبذلك يكون شكل موجة الإخراج كالاتي :-



The Integrator

The Integrator:- It is one of the inverting op-amp application as shown in figure bellow.



If = - I1 (1)

If=C $\frac{dVo}{dt}$ (2)

I1=V1/R1 (3)

Sub.(2) &(3) into (1)

$C\frac{dvo}{dt} = -\frac{V1}{R1}$ (4)

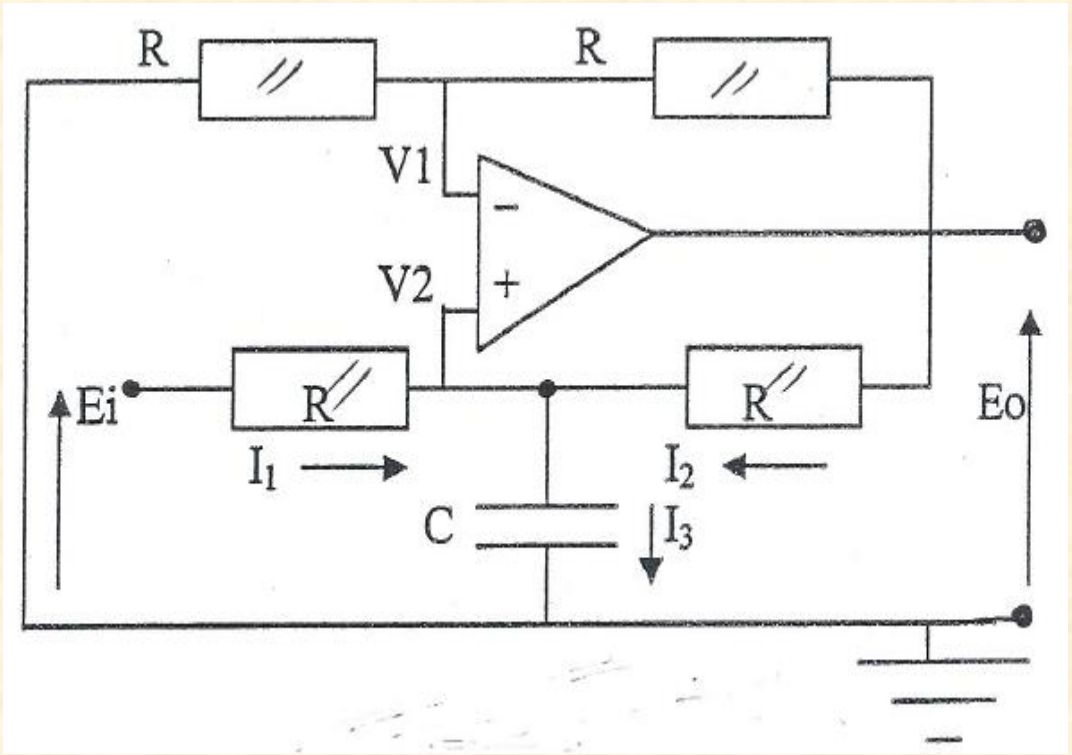
Integrate both side of eq.4 and solve yields:-

Vo= $-\frac{1}{R1C}\int V1\, dt$ (5)

Example

The circuit shown in Figure bellow:- show that the output Eo is given as

$$Eo = \frac{2}{Rc}\int Ei\, dt$$



SOL.

V1=V2 (1)

V1=[R/R+R]Eo = ½ Eo (2)

I1+I2=I3 (3)

$$\frac{Ei-V1}{R}+\frac{EO-V1}{R}=C\frac{dV1}{dt} \quad (3)$$

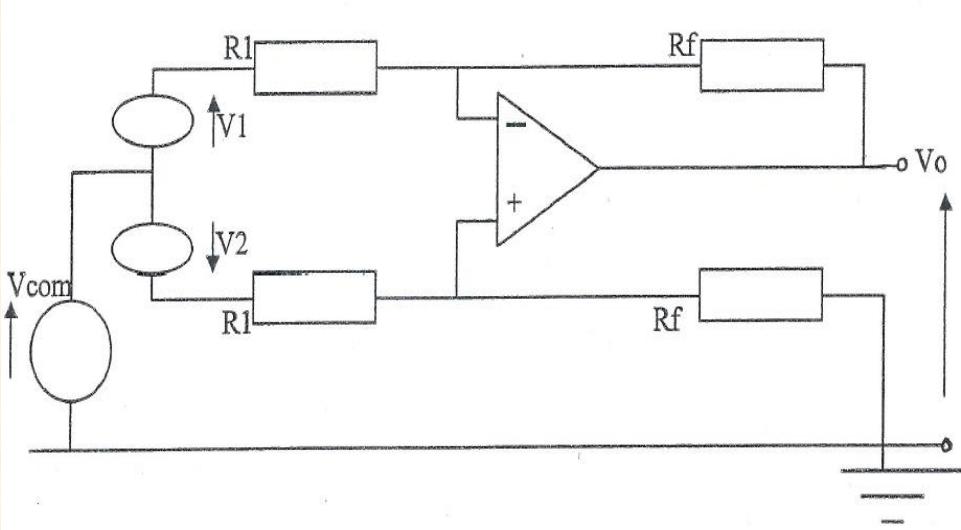
$$\frac{Ei-(\frac{1}{2})Eo}{R}+\frac{EO-(\frac{1}{2})Eo}{R}=C\frac{d(\frac{1}{2})Eo}{dt}$$

$$Eo=\frac{2}{RC}\int Eidt$$

The Differential Op-amp

The Differential Op-amp

$$Vo = [V2 - V1]\frac{Rf}{R1}$$



OP-AMP Voltage follower

OP-AMP Voltage follower

Vo= $V1$