Differentiator

$\frac{d}{dx} \rightarrow$ slope

Current flowing through capacitor

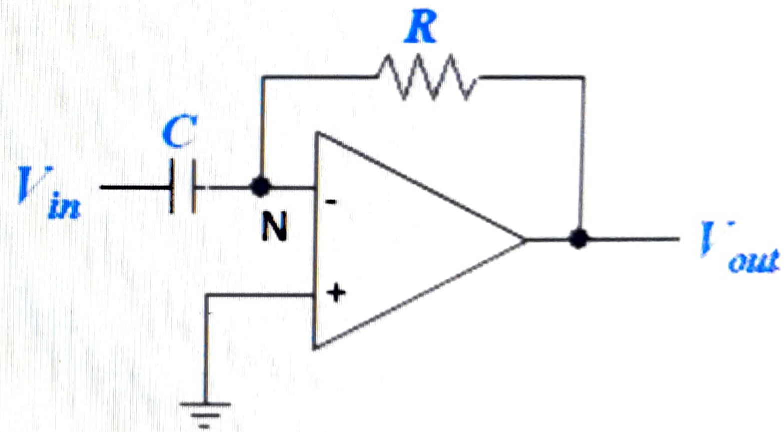
$$i_C = C\frac{d}{dt}(v_i - v_N) = C\frac{dv_i}{dt}$$

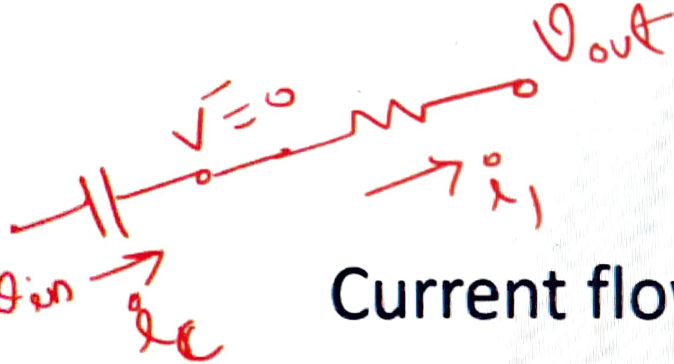
Nodal equation at N

$$C\frac{dv_i}{dt} + \frac{v_o}{R_F} = 0$$

Solving

$$v_o = -R_F C\frac{dv_i}{dt}$$





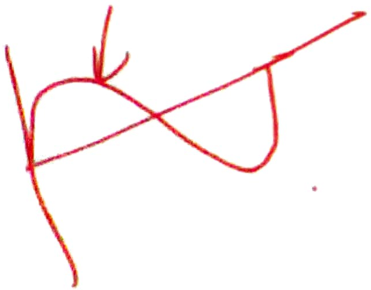
Differentiator

$\frac{d}{dx} \rightarrow$ slope

Current flowing through capacitor

$$i_C = C\frac{d}{dt}(v_{in} - v_N) = C\frac{dv_{in}}{dt}$$

sine



Nodal equation at N

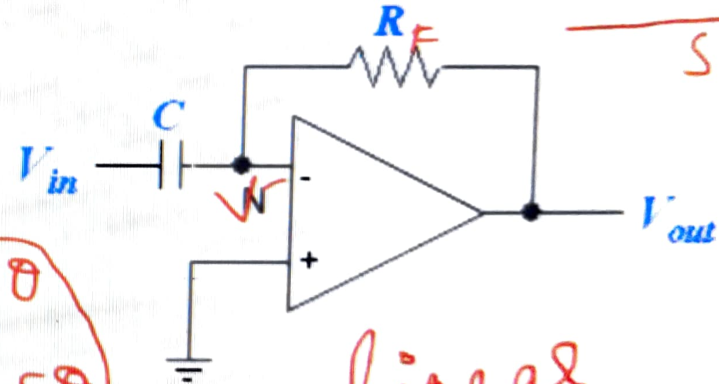
$$C\frac{dv_i}{dt} + \frac{v_o}{R_F} = 0$$

Solving

$$\boxed{v_o = -R_F C\frac{dv_{in}}{dt}}$$

$v_{in} = A\sin\theta$

$v_o = (\ )\cos\theta$



linear

$V^- = V^+ = 0$

The differentiator circuit of Fig. uses $C = 1\,\mu F$ and $R = 1\,M\Omega$. In addition to the required input voltage, a noise signal due to mains 'hum' also appears at the input. If the input noise signal $v_n = 5 \sin 314t$ mV, determine the resulting noise signal at the output.

A

$CR = 10^{-6} \times 10^{6} = 1\,s$

noise – 5 mV

1.57 V

$$\text{output noise, } V_{on} = -CR\frac{d}{dt}(5 \sin 314\omega t)\ \text{mV}$$

$$= 5 \times 314 \cos 314t\ \text{mV}$$

$$V_{on} = 1.57 \cos 314t\ \text{V}\ \textbf{Ans}$$

$v_o = -RC\dfrac{dv_{in}}{dt}$

Integrator

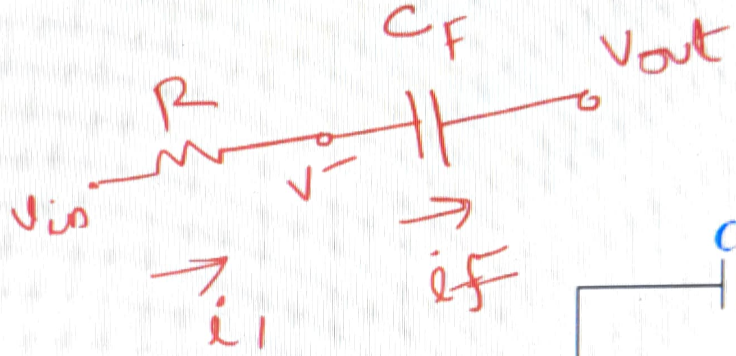
Nodal equation at N

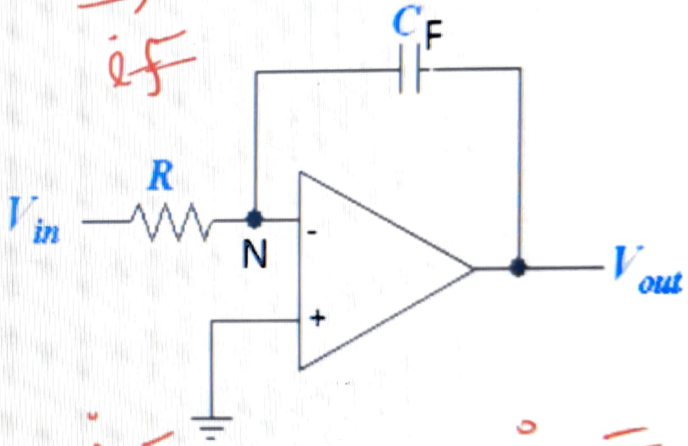
$$\frac{v_i}{R_1} + C_F \frac{dv_o}{dt} = 0$$

$$\frac{dv_o}{dt} = -\frac{1}{R_1 C_F} v_i$$

Integrating on both sides

$$v_o = -\frac{1}{R_1 C_F} \int_0^t v_i(t)\, dt$$





$$i_1 = i_F \qquad i_F = C_F \frac{d(0 - v_o)}{dt}$$

$$i_1 = \frac{V_{in} - 0}{R} \qquad = -C_F \frac{dv_o}{dt}$$

Q **An integrator circuit is shown in Fig. 11. For this circuit determine the output voltage when $V_1 = 25 \sin(314t)$ volt.**

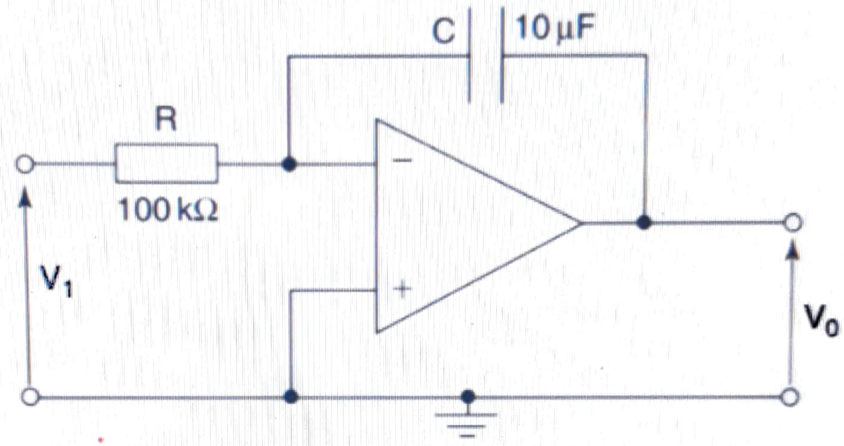


Fig. 11

A

$$V_o = \frac{-6}{CR}\int V_i\, dt \text{ volt}$$

$$= \frac{-1}{10^{-5}\times 10^5}\int 25 \sin(314t)dt$$

$$= \frac{-1}{314}(-25 \cos 314t)$$

$V_o = 79.6 \cos(314t)$ mV **Ans**

Assignment B.2

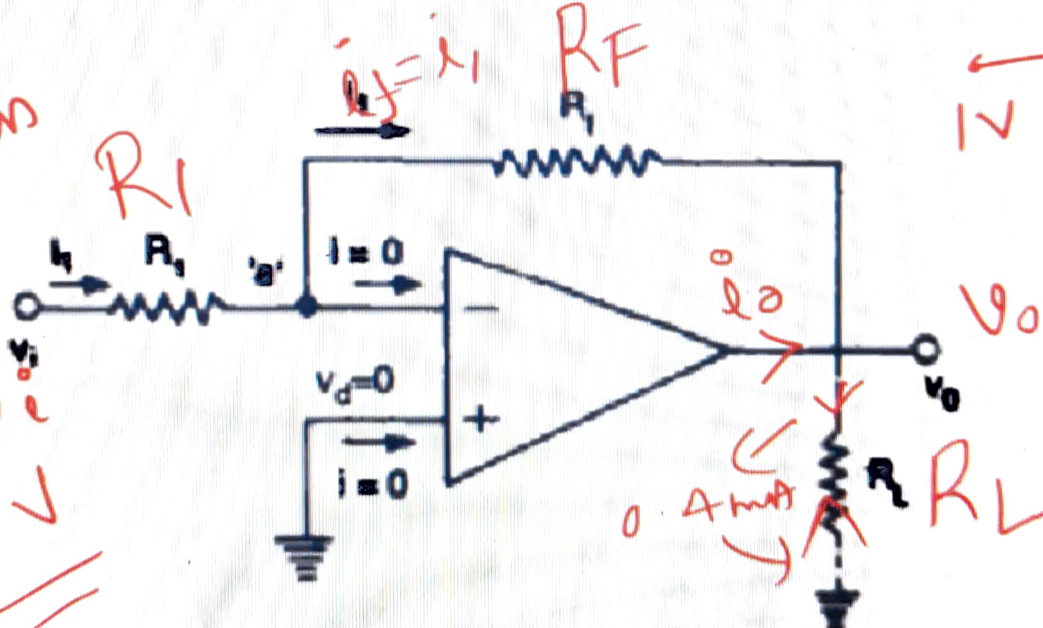
- $R_1 = 10\ k\Omega$, $R_f = 100\ k\Omega$, $v_i = 1\ V$. A load of $25\ k\Omega$ is connected to the output terminal. Calculate (1) i_1 (2) v_o (3) i_L and (4) total current i_o into the output pin.

inverting

$v_o = -\left[\frac{R_f}{R_1}\right] v_{in}$

$= -10\, v_{in}\ v_i$

$= -10\ V$



1V 10K 0V

$i_1 = \frac{1-0}{10K}$

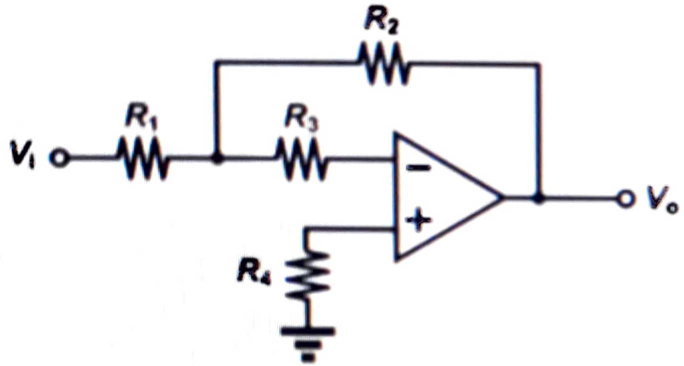
$= 0.1\ mA$

v_o

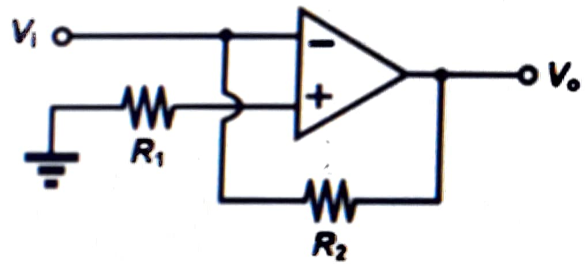
$i_L = \frac{v_o}{R_L} = -0.4\ mA$

Assignment B.1

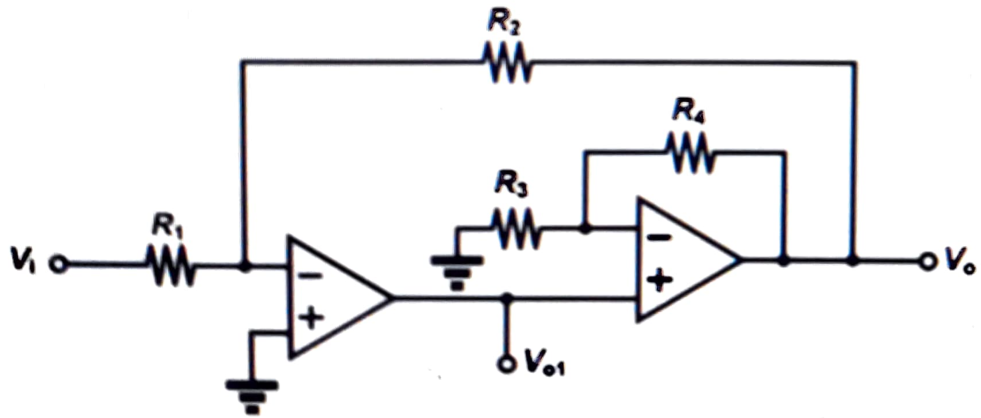
(1)



(2)

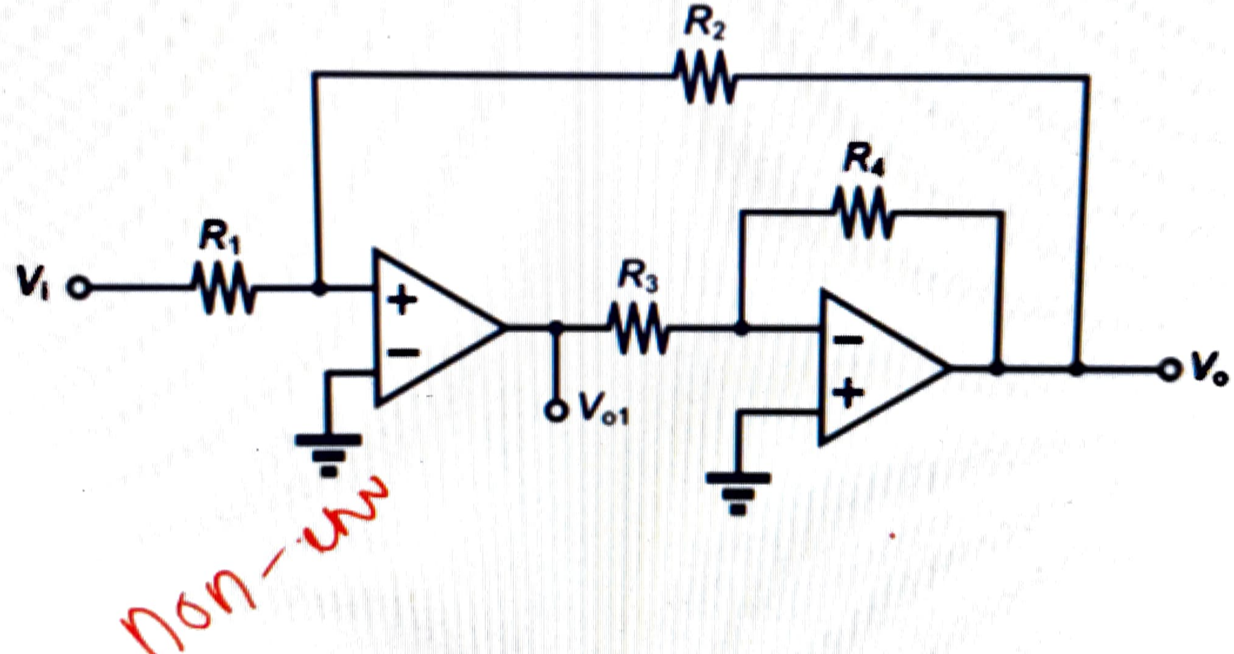


(3)



Assignment B.1

(4)

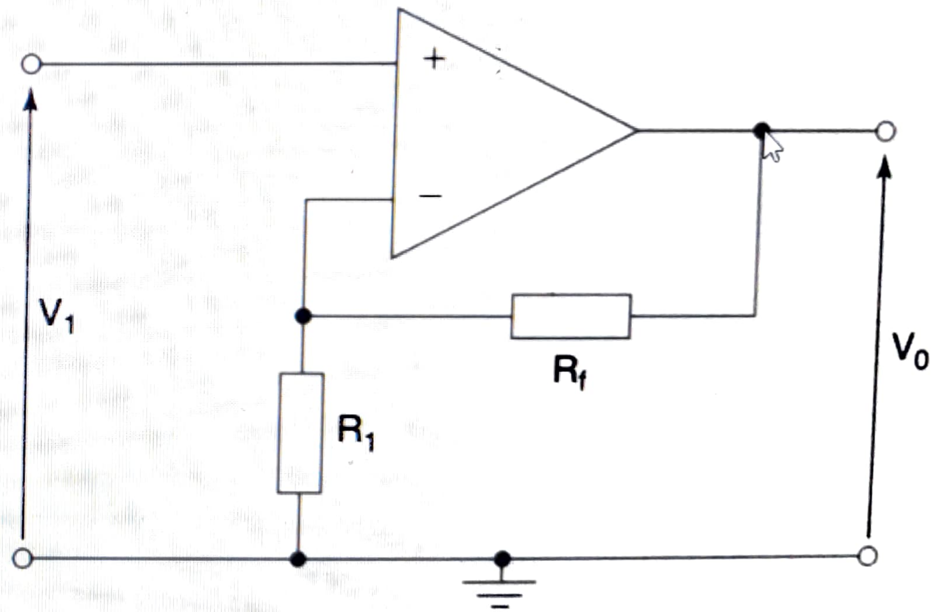


The circuit of Fig.   has the following combination of inputs and resistors applied. In each case calculate the resulting output voltage.

(a) $R_f = 1\,M\Omega; R_1 = 100\,k\Omega; V_1 = 0.6\,V$

(b) $R_f = 100\,k\Omega; R_1 = 1\,M\Omega; V_1 = -1.5\,V$

(c) $R_f = 100\,k\Omega; R_1 = 1\,M\Omega; V_1 = 5 \sin \omega t$ volt



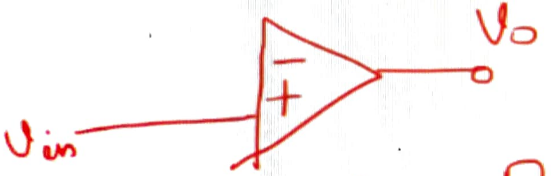
The circuit of Fig. has the following combination of inputs and resistors applied. In each case calculate the resulting output voltage.

(a) $R_f = 1\,\text{M}\Omega;\ R_1 = 100\,\text{k}\Omega;\ V_1 = 0.6\,\text{V}$ → 6.6V

(b) $R_f = 100\,\text{k}\Omega;\ R_1 = 1\,\text{M}\Omega;\ V_1 = -1.5\,\text{V}$ → -1.65 V

(c) $R_f = 100\,\text{k}\Omega;\ R_1 = 1\,\text{M}\Omega;\ V_1 = 5 \sin \omega t$ volt →

$1\left(1 + \frac{10^5}{10^6}\right)$

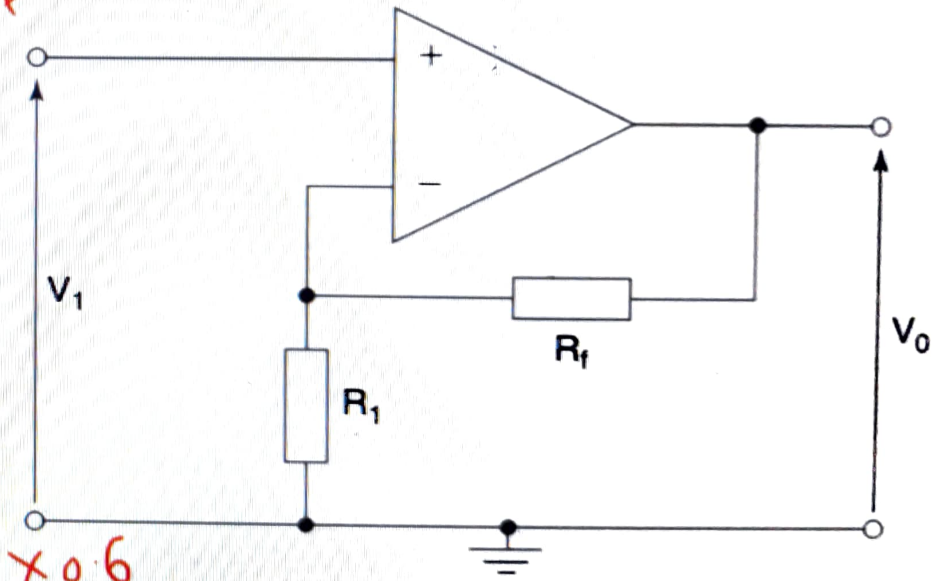


$$V_o = \left(1 + \frac{R_f}{R_1}\right) V_{in}$$

$$= \left(1 + \frac{10^6}{10^5}\right) 0.6$$

$$= 11 \times 0.6$$

$$= 6.6\,\text{V}$$



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5.5sin(omega*t)

Q For the circuit of Fig. 7 the following combination of input voltages and resistors is applied. For each case calculate the resulting output voltage.

(a) $R_1 = R_2 = 100\,k\Omega$; $V_1 = 6.4V$; $V_2 = 10.5V$

(b) $R_1 = R_2 = 1\,M\Omega$; $V_1 = 2.6V$; $V_2 = -4V$

(c) $R_1 = 100\,k\Omega$; $R_2 = 1\,M\Omega$; $V_1 = 4.9V$; $V_2 = 3.8V$

Difference op-amp

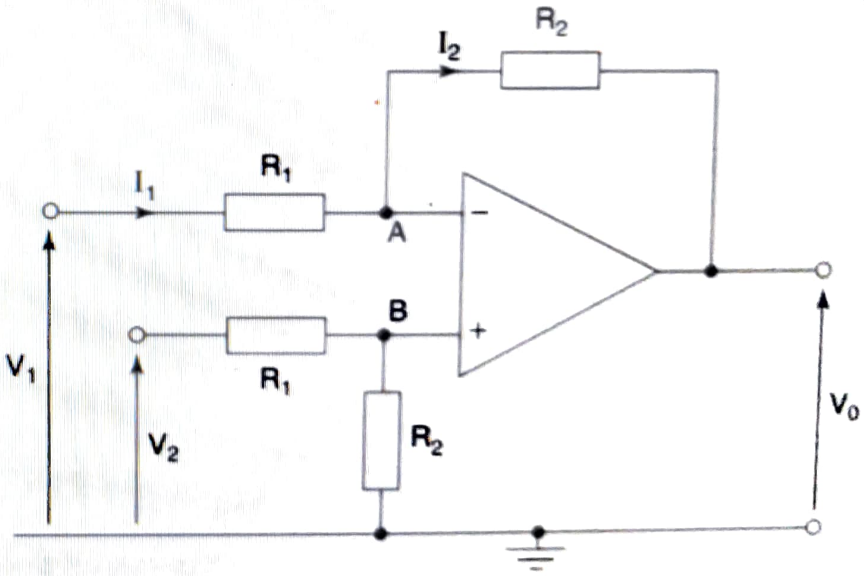

Fig. 7