06.06.2021
05 June 2021 20:38

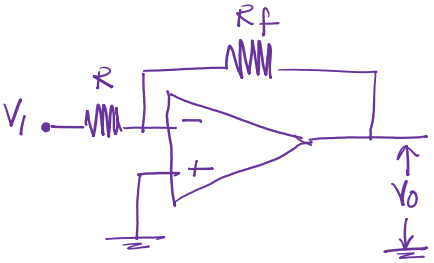
Realize each of the following equations using single OPAMP. Draw the circuit diagram. Derive the input output relation and determine the component values.

(i) $V_o = -5V_1$

(ii) $V_o = +5V_1$ (iii) $V_o = -(5V_1 + 7V_2)$ (iv) $V_o = V_1 - 0.5V_2$

(i) $V_o = -5V_1 \rightarrow (2)$

Inverting amplifier



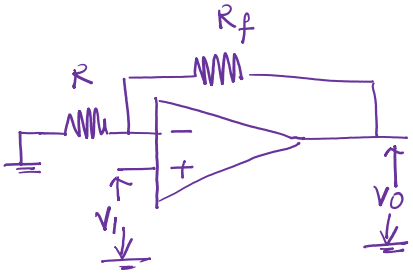
$V_o = -\frac{R_f}{R} V_1 \rightarrow (1)$

$\frac{R_f}{R} = 5$ (① & ② from)

$R_f = 5R$

(ii) $V_o = +5V_1$

Non-inverting amplifier

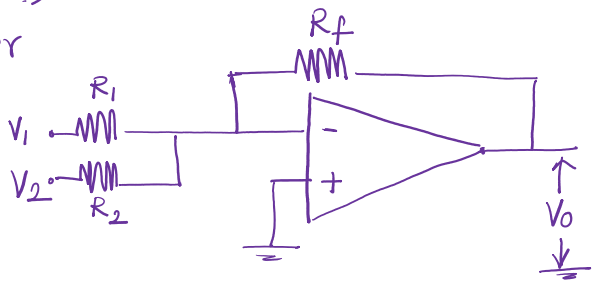


$V_o = \left(1 + \frac{R_f}{R}\right) V_1$

$1 + \frac{R_f}{R} = 5$; $R_f = 4R$

(iii) $V_o = -(5V_1 + 7V_2)$

Inverting Adder



$V_o = -\left(\frac{R_f}{R_1} V_1 + \frac{R_f}{R_2} V_2\right)$

$\frac{R_f}{R_1} = 5$, $\frac{R_f}{R_2} = 7$

$R_1 = \frac{R_f}{5}$, $R_2 = \frac{R_f}{7}$

2- $V_o = 4V_1 + 5V_2$

Realize the equation using OPAMP, $V_0 = 3V_1 - 0.8V_2 + 0.5V_3$

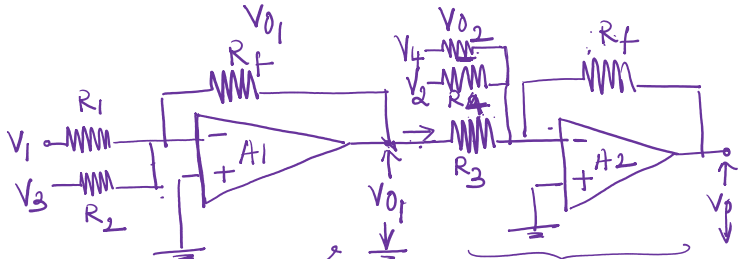
INVERTING ADDER followed by INVERTING AMP of GAIN = 1

$V_o = (3V_1 + 0.5V_3) - (0.8V_2)$

$3V_1 - 0.8V_2 + 0.5V_3 - V_4$

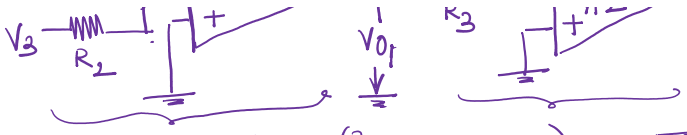
$(3V_1 + 0.5V_3) - (0.8V_2 + V_4)$

V_{o1} V_{o2}



$3V_1 + 0.5V_3$

$V_o = (3V_1 + 0.5V_3)\left(-\frac{R_f'}{R_3}\right) - \frac{R_f'}{R_4} V_2$

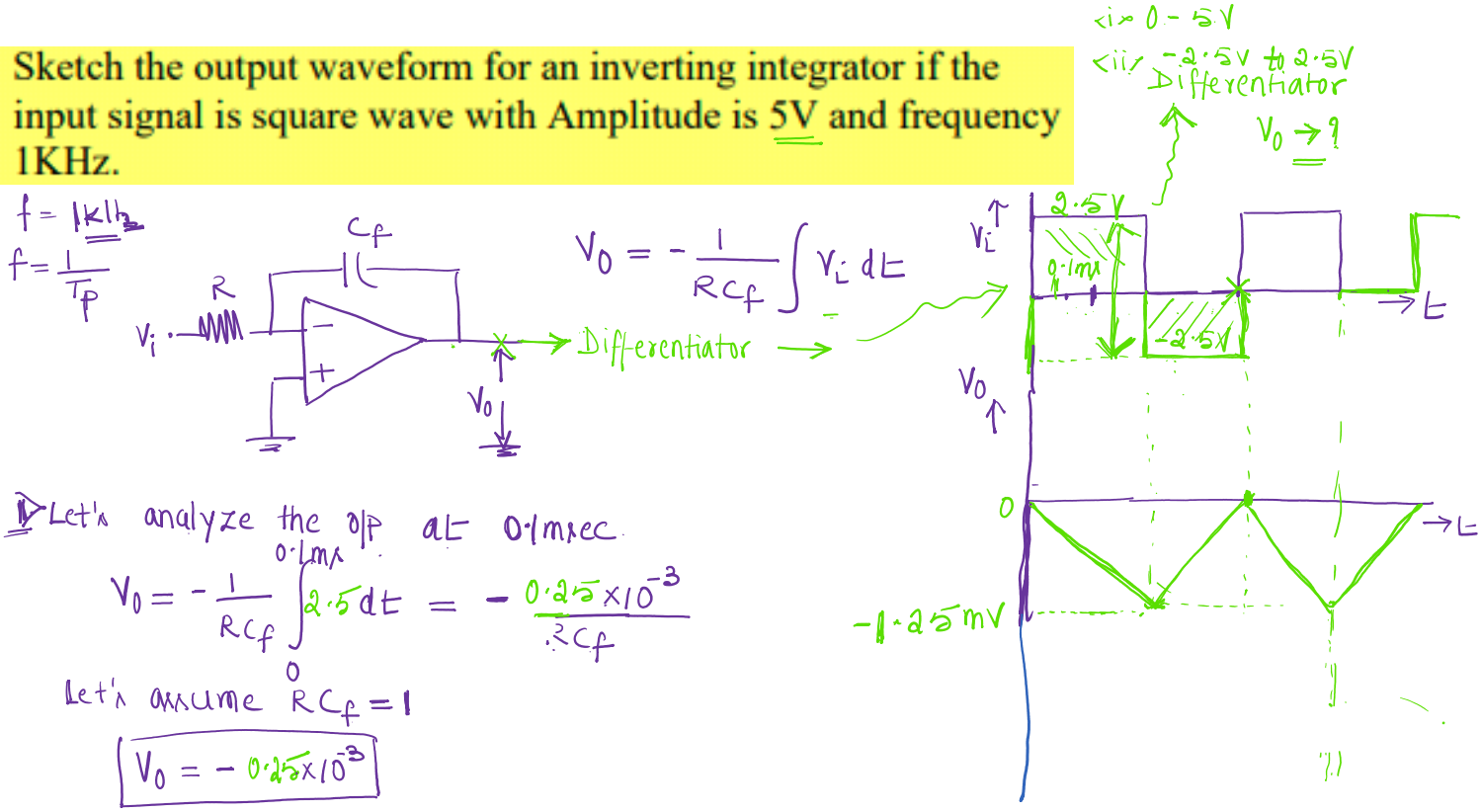


$$V_{01} = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2\right) \qquad \boxed{R_f = R_3} \qquad \frac{R_f}{R_4} = 0.8 \;;\; \boxed{R_4 = \frac{R_f}{0.8}}$$

$$\frac{R_f}{R_1} = 3 \;;\; R_1 = R_f/3$$

$$\boxed{\frac{R_f}{R_2} = 0.5 \;;\; R_2 = R_f/0.5}$$

Sketch the output waveform for an inverting integrator if the input signal is square wave with Amplitude is 5V and frequency 1KHz.



(i) Let's analyze the o/p at 0.1msec

$$V_0 = -\frac{1}{RC_f}\int_0^{0.1ms} 2.5\,dt = -\frac{0.25\times10^{-3}}{RC_f}$$

Let's assume $RC_f = 1$

$$\boxed{V_0 = -0.25\times10^{-3}}$$

(ii) Let analyse the o/p at 0.3msec

$$V_0 = -\frac{1}{1}\int_0^{0.3ms} 2.5\,dt \Rightarrow \boxed{-0.75\times10^{-3} = V_0}$$

(iii) At 0.5ms; $\boxed{V_0 = -1.25\times10^{-3}}$

(iv) At 0.8ms; $V_0 = -\frac{1}{1}\int_0^{0.8ms} V_i\,dt = -\left\{\int_0^{0.5ms} 2.5\,dt + \int_{0.5ms}^{0.8ms} -2.5\,dt\right\} = -1.25mV + 0.75mV$

$$\boxed{V_0 = -0.5\times10^{-3}}$$

An amplifier using an OP-AMP with a slew rate of 1V/µsec has a gain of 40dB. If the amplifier has to faithfully amplify sinusoidal signal of 20KHz without any induced slew rate induced distortion, then find the maximum value of input signal.

GIVEN DATAS :- $S.R = 1V/\mu s = 1\times10^{6} V/s$

$GAIN = 40dB \Rightarrow 20\log_{10}(A_V) = 40 ;\ A_V = 10^{2} = 100$

$f = 20KHz$

$V_{IN} = V_m \sin\omega t = V_m \sin(2\pi \times 20\times10^{3} \times t)$

$V_{OUT} = A_V \cdot V_{IN} = 100 \times V_m \sin(2\pi\times20\times10^{3}t)$; $\frac{dV_{OUT}}{dt} = 100V_m \cdot (2\pi\times20\times10^{3}) \cos(2\pi\times20\times10^{3}t)$

$S.R = \left.\frac{dV_{out}}{dt}\right|_{max} \Rightarrow S.R = 100\,V_m(2\pi\times20\times10^{3})$

$1\times10^{6} = 100\,V_m(2\pi\times20\times10^{3})$

$\boxed{V_m = 0.0796V}$