CSET 102

Tutorial - 10 Solutions

Inverting amplifier

(1) $V_0 = \frac{-R_2}{R_1} V_{in} = \frac{15K}{1K}(0.5V) = 7.5V$

(2) $V_0 = -\frac{R_2}{R_1} V_{in} \Rightarrow R_2 = \frac{-V_0 R_1}{V_{in}} = \frac{15 \times 0.5K\Omega}{0.25V}$

$A_V = \frac{-V_0}{V_{in}}$ for inverting amplifier

$R_2 = 30 K\Omega$

Max Value of $V_0 = 15V$

(3) $R_1 = \frac{-R_2 V_{in}}{V_0} \Rightarrow \frac{7.5K \times 0.25V}{15} = 125\ \Omega$

(4) $V_{in} = -\frac{V_0 R_1}{R_2} \Rightarrow \frac{15 \times 1K\Omega}{10K\Omega} = 1.5V$

Non-inverting amplifier

(5) $V_0 = \left(1 + \frac{R_2}{R_1}\right) V_{in} = \left(1 + \frac{10K}{1K}\right) 0.5V = 5.5V$

(6) $\left(\frac{V_0}{V_{in}} - 1\right) R_1 = R_2 \Rightarrow R_2 = \left(\frac{15}{0.25} - 1\right) 0.5K = 29.5 K\Omega$

(7) $R_1 = \frac{R_2}{\left(\frac{V_0}{V_{in}} - 1\right)} = \frac{7.5K\Omega}{\left(\frac{15}{0.25} - 1\right)} \cong 127\Omega$

(8) $V_{in} = \frac{V_0}{\left(1 + \frac{R_2}{R_1}\right)} = \frac{15}{\left(1 + \frac{15K}{1K}\right)} \simeq 0.94V$

(9) <u>Summing amplifier</u>

$$V_0 = -R_f\left[\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right]$$

$$= -10K\Omega\left[\frac{0.5}{1K} + \frac{0.75\sin(60\pi t)}{1.5K} + \frac{1\sin(30\pi t)}{2K}\right]$$

$$= -10K\left[\frac{3 + 3\sin(60\pi t) + 3\sin(30\pi t)}{6K}\right]$$

$$V_0 = -\left[5 + 5\sin(60\pi t) + 5\sin(30\pi t)\right] V$$

(10) $$V_0 = -\frac{R_f}{R_1}V_1 - \frac{R_f}{R_2}V_2 - \frac{R_f}{R_3}V_3$$

$$\text{Gain} = \frac{-R_f}{R_1} = \frac{-R_f}{R_2} = \frac{-R_f}{R_3} = 5$$

$$V_0 = 5[(0.25) + 0.75\sin(60\pi t) + 1.2\sin(30\pi t)] V$$

(11)

Using Superposition theorem,

output Voltage of difference amplifier is

$$V_0 = \frac{R_4}{R_3 + R_4}\left[1 + \frac{R_2}{R_1}\right] V_{I2} - \frac{R_2}{R_1} V_{I1}$$

$$= \frac{9K}{12K}\left[1 + \frac{5K}{1K}\right] 0.55V - \left[\frac{5K}{1K}\right] 0.5V$$

$$= 2.475V - 2.5$$

$$V_0 = \underline{-0.025V} \quad \text{or} \quad -\underline{25mV}.$$

(12)

$$V_s = 1\sin(120\pi t)$$

$$V_o = \frac{-1}{RC}\int V_s\,dt$$

$$= \frac{-1}{1K \times 1\mu}\int \sin(120\pi t)\,dt$$

$$= \frac{-1}{10^{-3}}\left[-\frac{\cos(120\pi t)}{120\pi}\right] = \frac{1000\cos(120\pi t)}{120\pi}\ V$$

$$V_o = 2.65\cos(120\pi t)\ V.$$

(13)

$$V_o = -RC\frac{dV_s}{dt}$$

$$= -1K \times 1\mu \cdot \frac{d}{dt}\left[\sin(120\pi t)\right]$$

$$= -10^{-3}\cos(120\pi t) \times 120\pi$$

$$V_o = -0.377\cos(120\pi t)\ V.$$