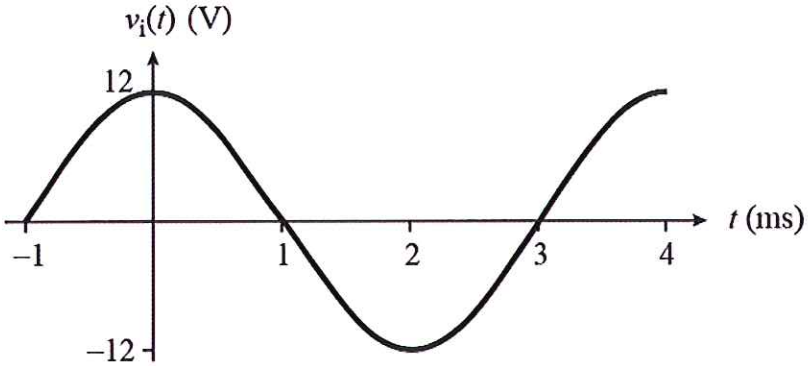
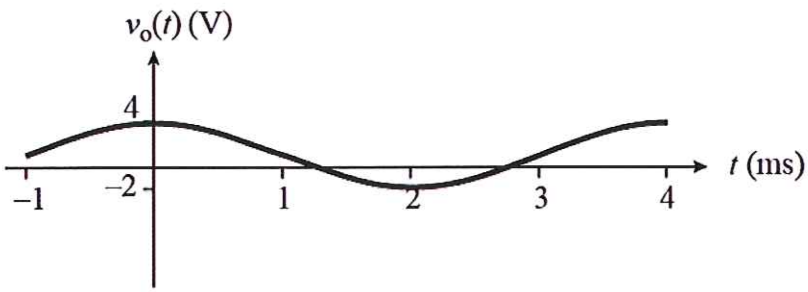
Ex:



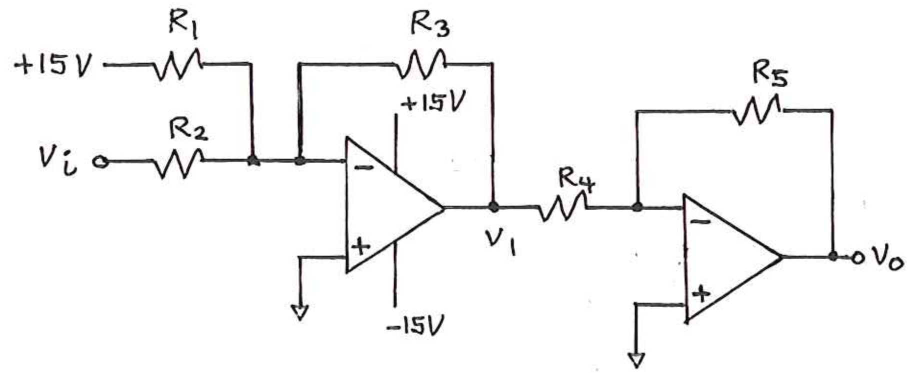


Using op-amps, power supplies, and resistors, draw a circuit to produce $v_o(t)$ from $v_i(t)$. (Assume you have a function generator that produces $v_i(t)$ for you to use.) Show all relevant information in your circuit, including positive and negative power supply voltages for op-amps. You may use only two power supplies in your design. You must generate other voltages you need from those two power supplies, (for example by using a voltage-divider).

Note: The output voltage is 1/4 as big as the input voltage and is shifted up by 1 V.

sol'n: For an offset and a gain that is positive, we need a summing amplifier and a second inverting amplifier.

We can design a circuit that outputs $-v_o(t)$.
So we want $v_o(t) = -\frac{1}{4} v_i(t) - 1V$.



For the first stage, $V_1 = -15\,V \dfrac{R_3}{R_1} - V_i \dfrac{R_3}{R_2}$.

For the second stage, $V_o = -\dfrac{R_5}{R_4} V_i = \left(15V \dfrac{R_3}{R_1} + V_i \dfrac{R_3}{R_2}\right) \dfrac{R_5}{R_4}$.

We want $\dfrac{R_3}{R_1} = \dfrac{1}{15}$ and $\dfrac{R_3}{R_2} = \dfrac{1}{4}$ for 1st stage.

$R_1 = 150\,k\Omega$, $R_2 = 40\,k\Omega$, $R_3 = 10\,k\Omega$ works, (many other sol'ns, too).

For the second stage we can use $R_4 = R_5 = 100\,k\Omega$. Again, many other solutions work as well.