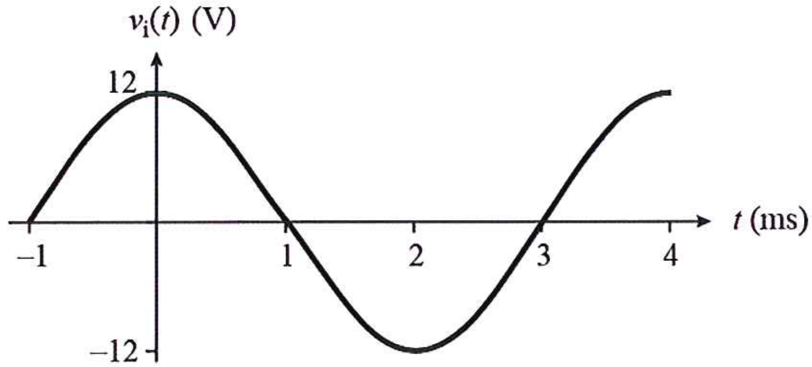
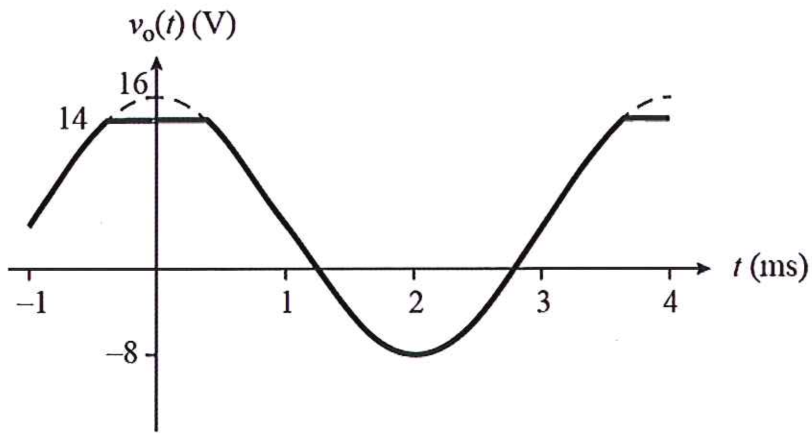
Ex:



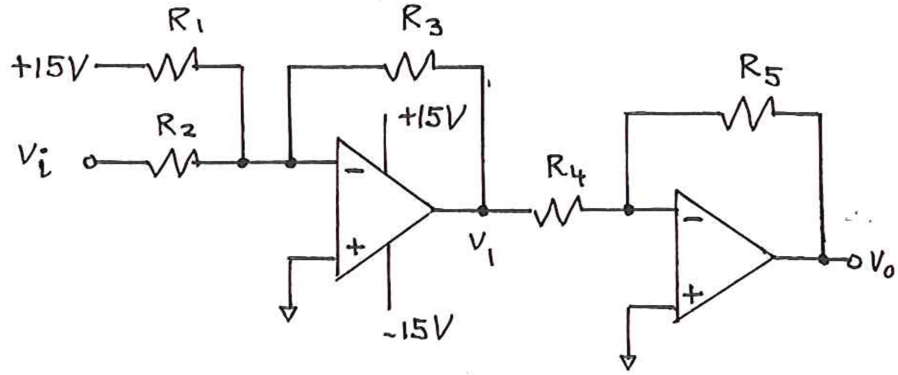


Using op-amps, power supplies, and resistors, draw a circuit to produce $v_o(t)$ from $v_i(t)$. (Assume you have a function generator that produces $v_i(t)$ for you to use.) Show all relevant information in your circuit, including positive and negative power supply voltages for op-amps. You may use only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

Note: The output voltage is the same amplitude (before clipping) as the input voltage and is shifted up by 4 V.

sol'n: We need a summing amp to shift the voltage, which means we will have negative gain. So we use a second negative-gain amplifier to invert the signal.

In the first stage, we need an offset of negative so it becomes positive when inverted.



For first stage, $v_1 = -15V \frac{R_3}{R_1} - v_i \frac{R_3}{R_2}$.

For second stage, $v_o = -v_o \frac{R_5}{R_4} = \left(15V \frac{R_3}{R_1} + v_i \frac{R_3}{R_2}\right)\frac{R_5}{R_4}$

We need $15V \frac{R_3}{R_1}\frac{R_5}{R_4} = 4V$ and $v_i \frac{R_3}{R_2}\frac{R_5}{R_4} = v_i$.

There are many possible solutions. A solution using standard R values is $R_1 = 75k\Omega$, $R_2 = 20k\Omega$, $R_3 = 20k\Omega$, $R_4 = 100k\Omega$, $R_5 = 100k\Omega$.

This gives $\frac{R_3}{R_1} = \frac{4}{15}$, $\frac{R_3}{R_2} = 1$, and $\frac{R_5}{R_4} = 1$.