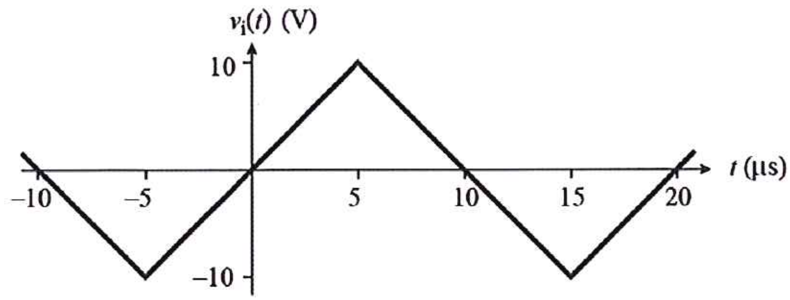
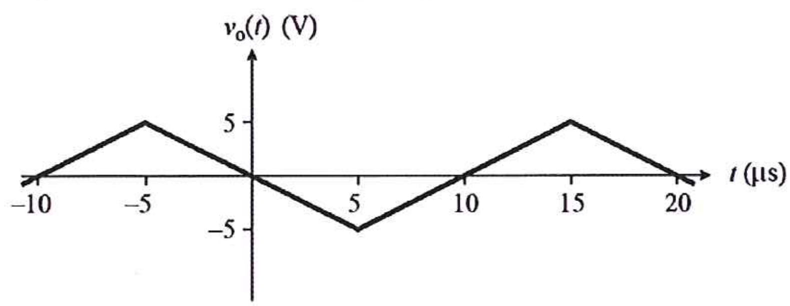
Ex:

A function generator outputs the following signal, $v_i(t)$.

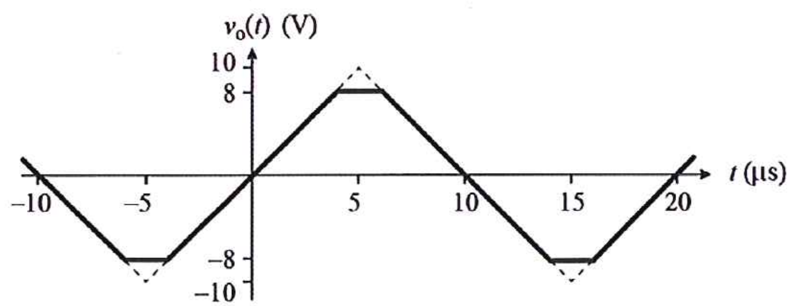


Design op-amp circuits to output each of the following waveforms when $v_i(t)$ is the input. You may use either one or two op-amps in each case.

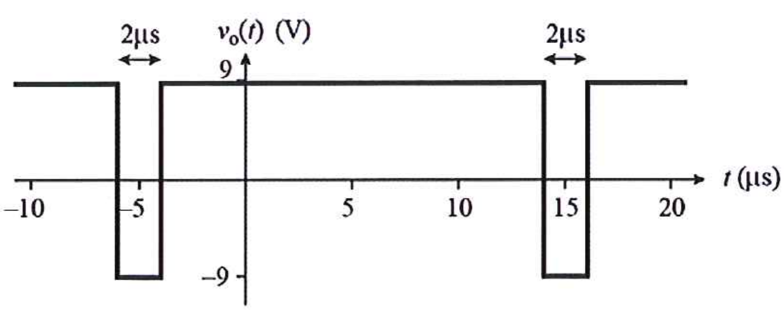
a)



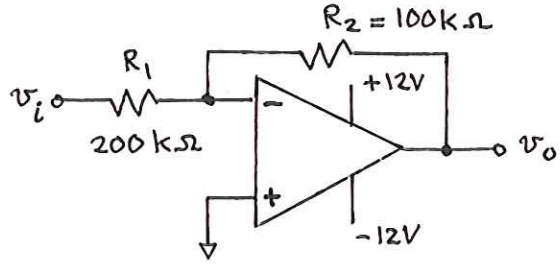
b)



c)



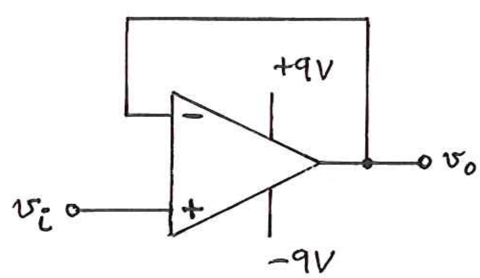
sol'n: a) We need an inverting amplifier with a gain of 0.5. We have $v_o = -v_i \, R_2/R_1$. So $R_2/R_1 = 1/2$.



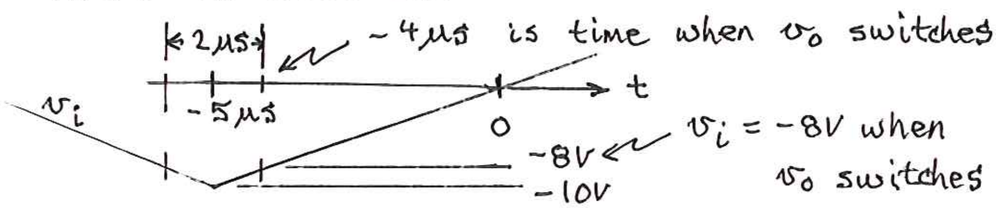
We use R's > 10 kΩ and R's < 1MΩ, and we use supply voltages of at least 6V and less than or equal to ±15V, which is a typical maximum supply voltage.

b) We need a non-inverting amplifier with a gain of one. We use supply voltages of $8 + 1V = 9V$ and $-8 - 1V = -9V$ to get clipping at ±8V.

For a gain of one, we use a buffer.



c) To get a PWM wave, we use a comparator. We use supply voltages ±10V to get ±9V output. We now determine the input voltage where v_o switches.



So we need a reference voltage going into the comparator of −8V. To avoid using an additional v-source, we use a v-divider for the −8V reference.

$$v_{ref} = -10V \cdot \frac{R_1}{R_1 + R_2} = -8V$$

One solution is 120kΩ and 30kΩ. The key is to have a ratio of four to one.

Finally, v_o is high when $v_i > -8V$. So we want v_i to go into the + input of the comparator.