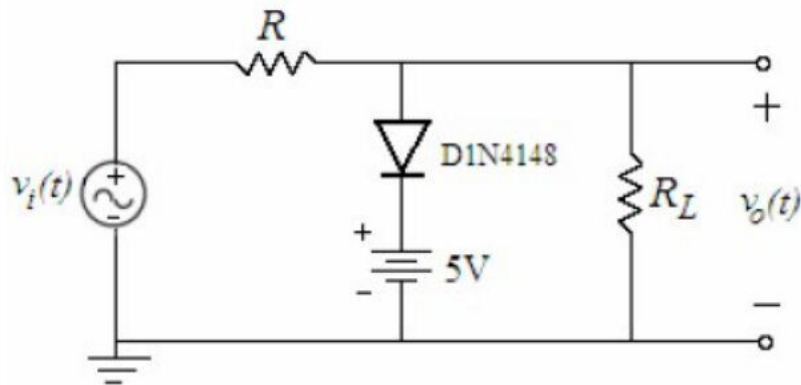


2)
a)



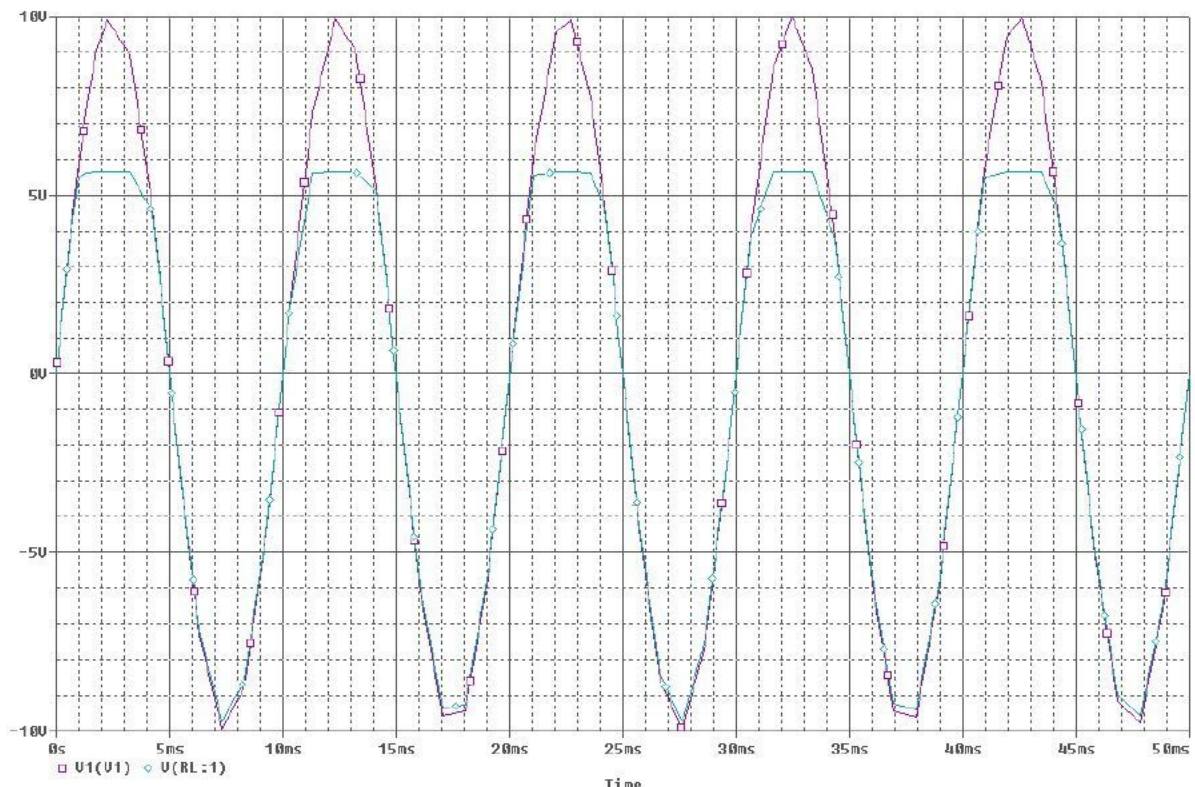
We can easily see that $v_o(t)$ will be clipped at $(5V + V_{diode}) = 5 + 0.7 = 5.7$ Volts. D1 will be off for $v_i(t) < V_{DC} + V_{diode}$, so $v_o(t)$ will be equal to $v_i(t)$ for $v_i(t) < V_{DC} + V_{diode}$.

If we change the DC voltage to another value, this time $v_o(t)$ will be clipped at $(V_{DC} + V_{diode})$.

If we rotate the DC voltage, $v_o(t)$ will be clipped at $(-V_{DC} + V_{diode})$ but this time D1 will be off for $v_i(t) < -V_{DC} + V_{diode}$, so $v_o(t)$ will be equal to $v_i(t)$ for $v_i(t) < -V_{DC} + V_{diode}$. But for $v_i(t) > -V_{DC} + V_{diode}$, D1 will be on and $v_o(t)$ will be equal to $-V_{DC} + V_{diode}$.

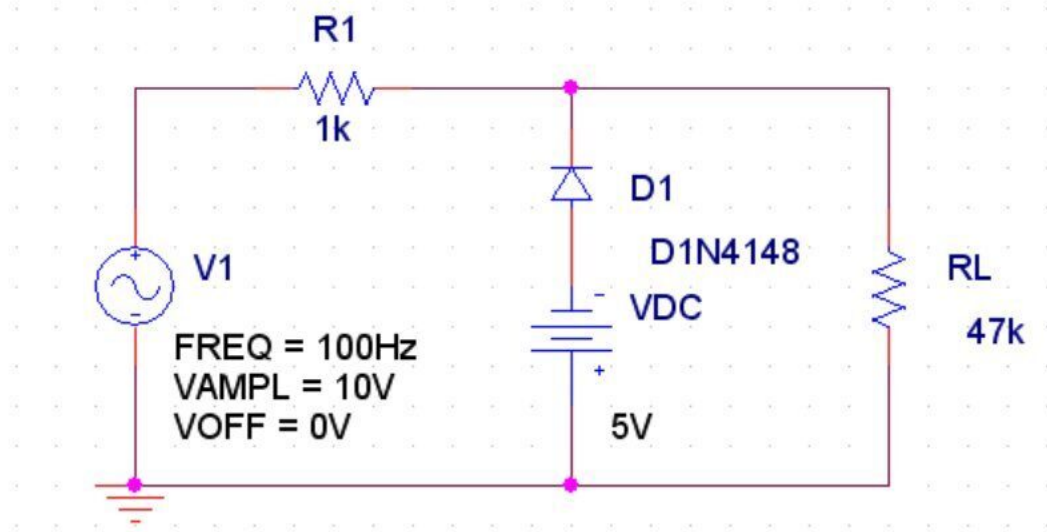
The minimum values are **not** the same since for $v_i(t) < V_{DC} + V_{diode}$, D1 is off, so $v_o(t)$ will be equal to $v_i(t) \times (R_L / (R_L + R)) = v_i(t) \times (47/48)$

(The self-plotted graphs are attached to the end of the document)
(PSPICE generated graph)



b)

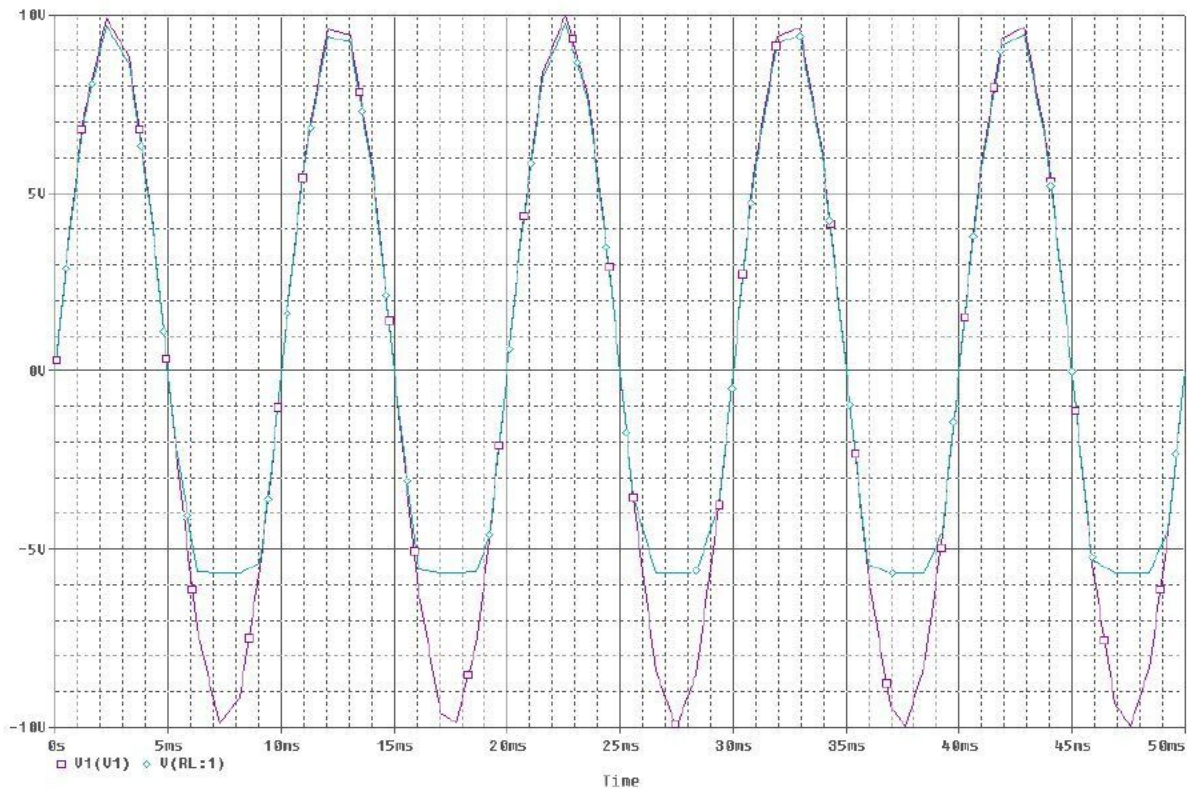
This time the circuit becomes:



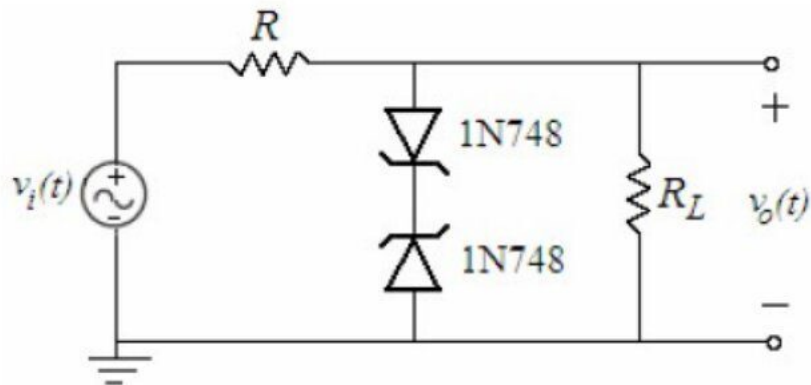
D1 is off for $v_i(t) > -(V_{DC} + V_{diode})$ so that $v_o(t)$ will be equal to $v_i(t) \times (47/48)$ for $v_i(t) > -(V_{DC} + V_{diode})$. But for $v_i(t) < -(V_{DC} + V_{diode})$, D1 will be on and $v_o(t)$ will be equal to $-(V_{DC} + V_{diode})$.

For this circuit, $V_{DC} = 5V$, so $v_o(t)$ will be equal to $v_i(t) \times (47/48)$ for $v_i(t) > -5.7$ and $v_o(t)$ will be equal to -5.7 for $v_i(t) < -5.7$.

(The self-plotted graphs are attached to the end of the document)
(PSPICE generated graph)



3)
a)



We can see from the maintained pdf file that 1N748 Zener diode has a zener voltage of :
 $V_Z = 3.9 \text{ V}$

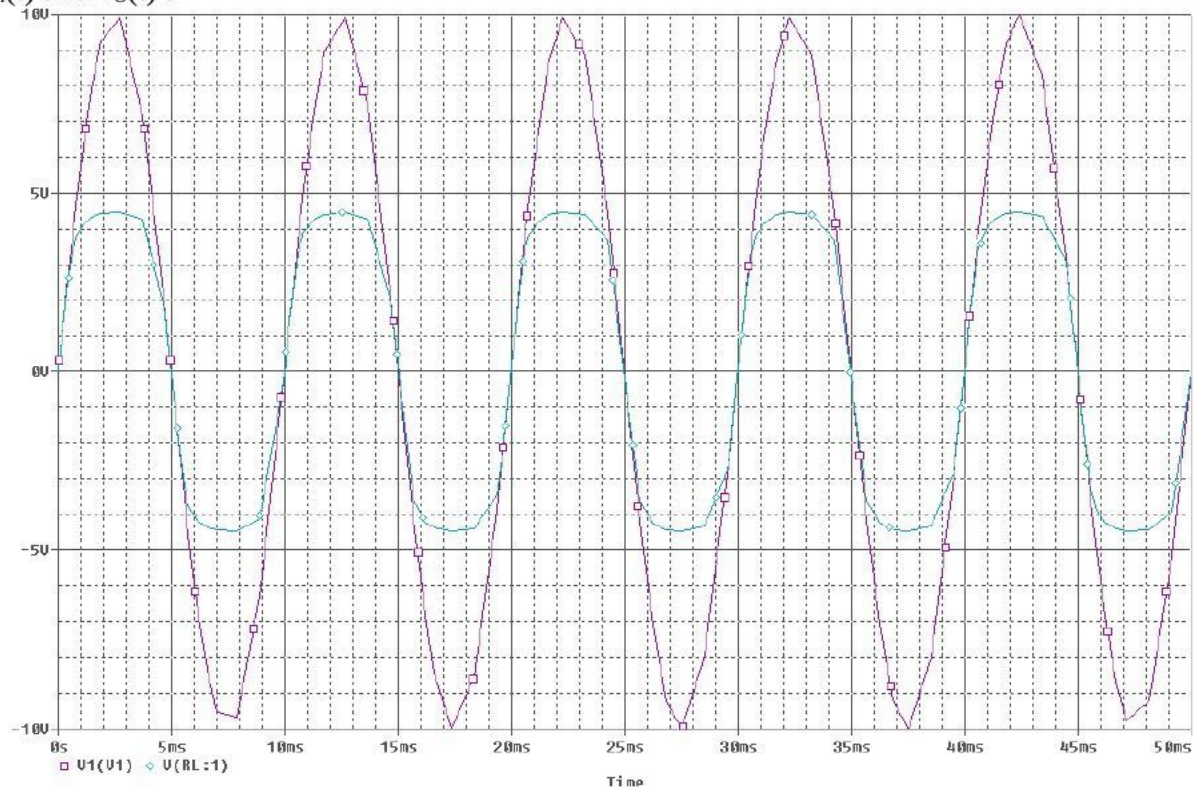
Let's analyze this circuit as well. For $v_i(t) > 0$, D1 will act like a normal diode while D2 will regulate the voltage and won't let its terminals to exceed 3.9 Volts. The total voltage is $V_Z + V_{\text{diode}} = 3.9 + 0.7 = 4.6 \text{ Volts}$. So for $v_i(t) > 4.6 \text{ Volts}$, $v_o(t)$ will be equal to 4.6.

For $v_i(t) < 0$, D2 will act like a normal diode while D1 will regulate the voltage and won't let its terminals to exceed 3.9 Volts. The total voltage is $-V_Z - V_{\text{diode}} = -3.9 - 0.7 = -4.6 \text{ Volts}$. So for $v_i(t) < -4.6 \text{ Volts}$, $v_o(t)$ will be equal to -4.6.

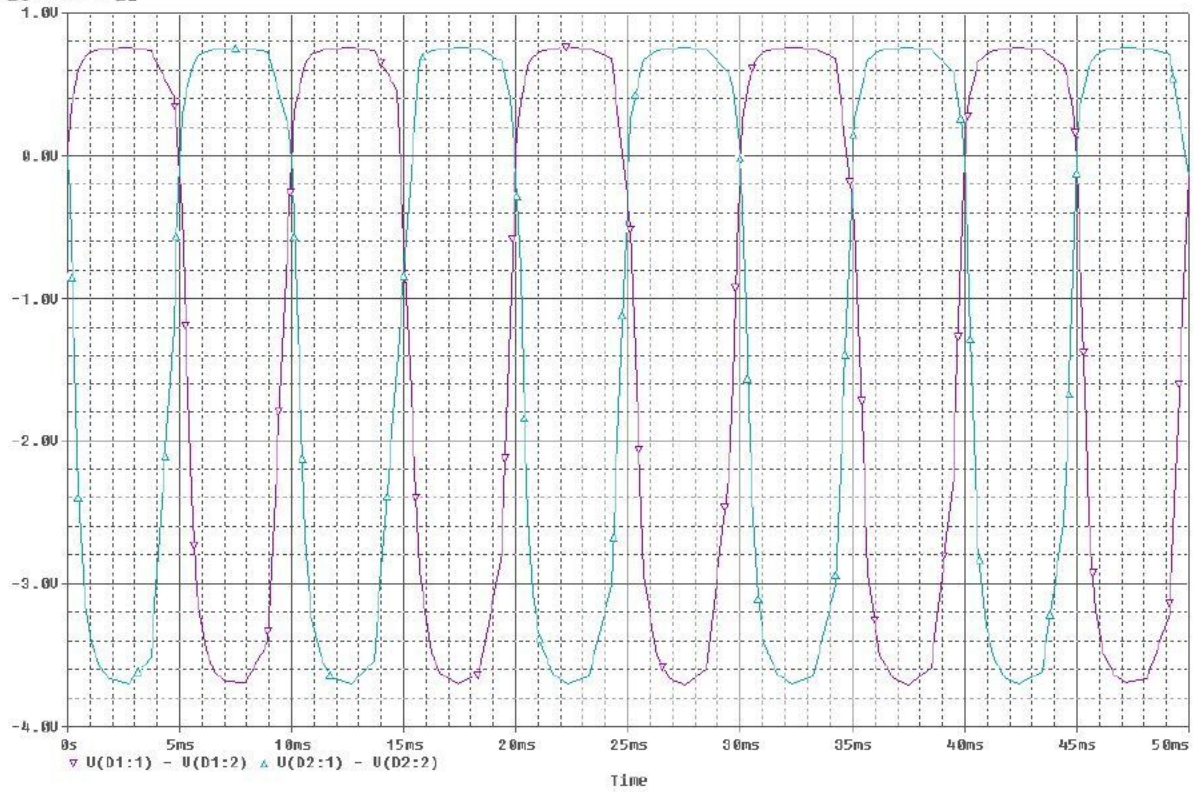
For $4.6 > v_i(t) > -4.6$, $v_o(t)$ will be equal to $v_i(t) \times (47/48)$
 (The self-plotted graphs are attached to the end of the document)

(PSPICE generated graphs)

$v_i(t)$ and $v_o(t)$:

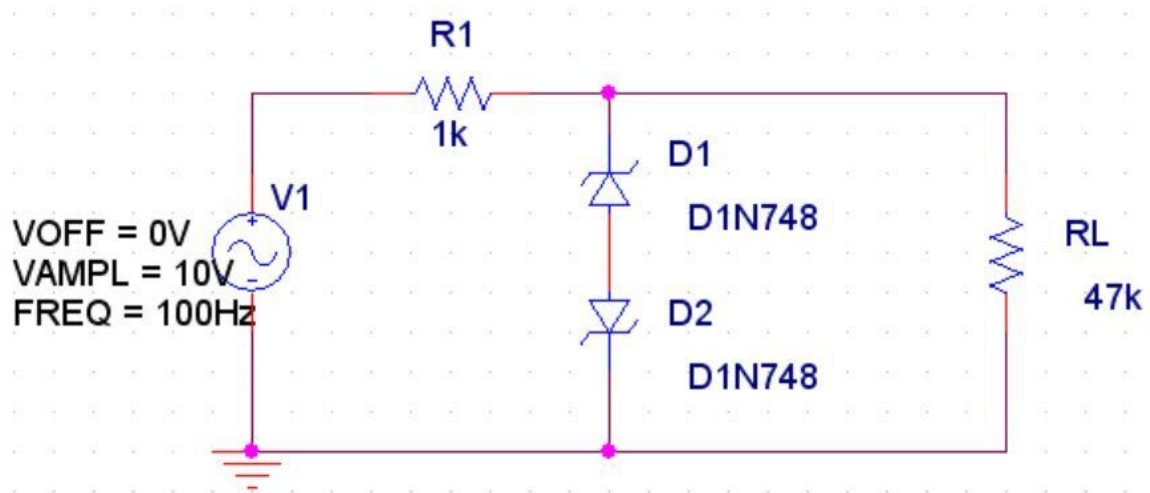


V_{D1} and V_{D2}



b)

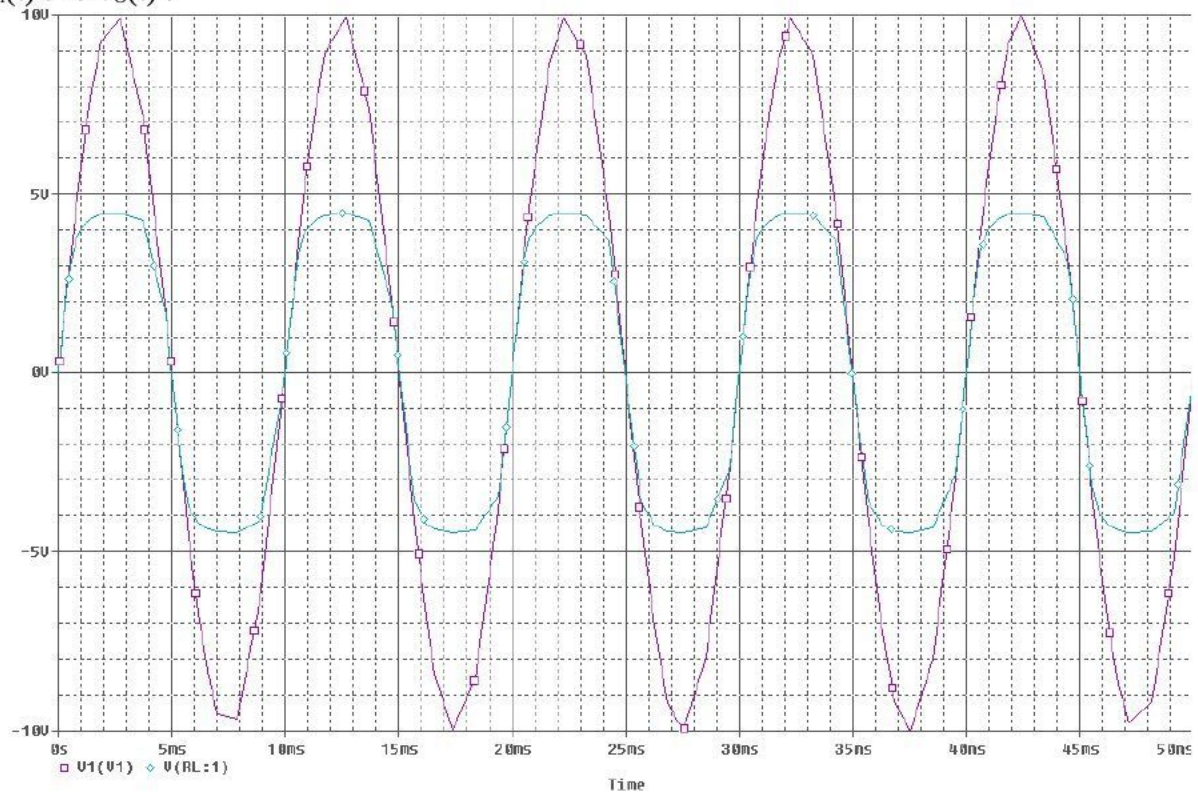
The circuit becomes:



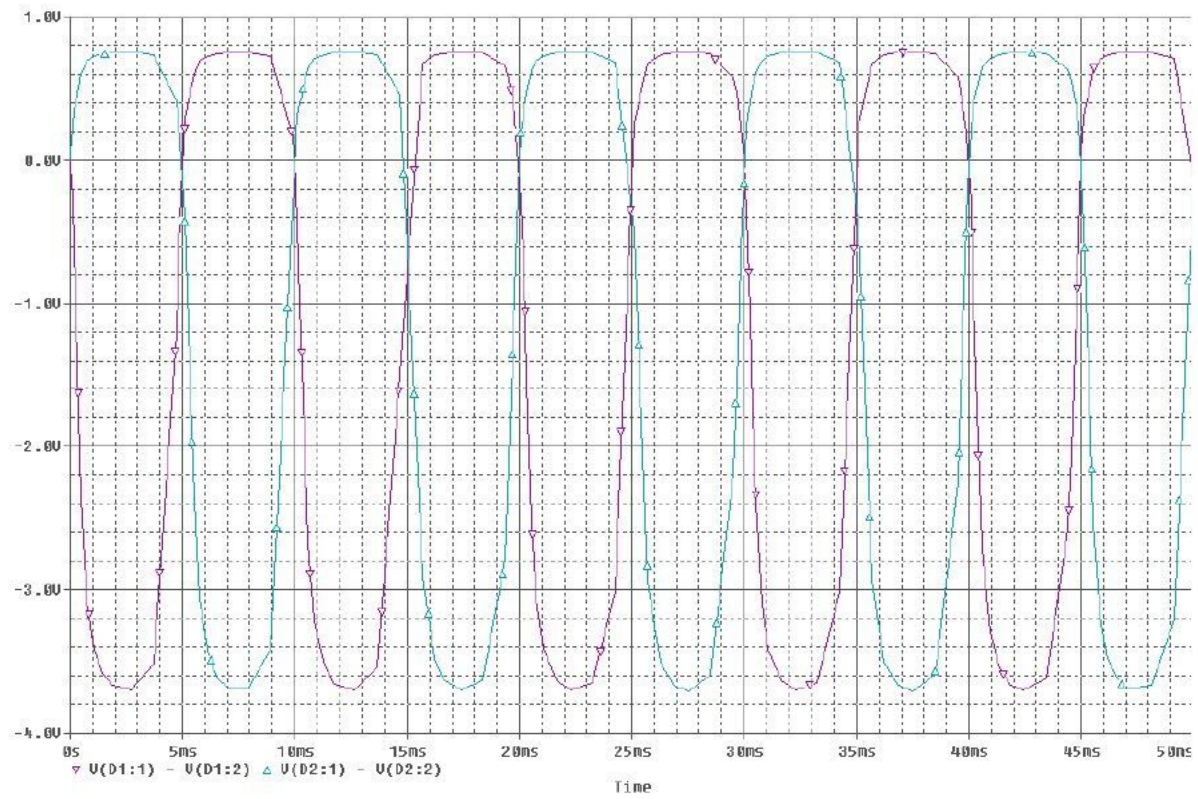
The output voltage doesn't change since in this circuit, D1 does D2's job and vice versa with respect to the circuit in 3-a). But D1's and D2's voltages are changed, their voltages are inverted w.r.t. the t-axis.

(PSPICE generated graphs)

$v_i(t)$ and $v_o(t)$:



V_{D1} and V_{D2}

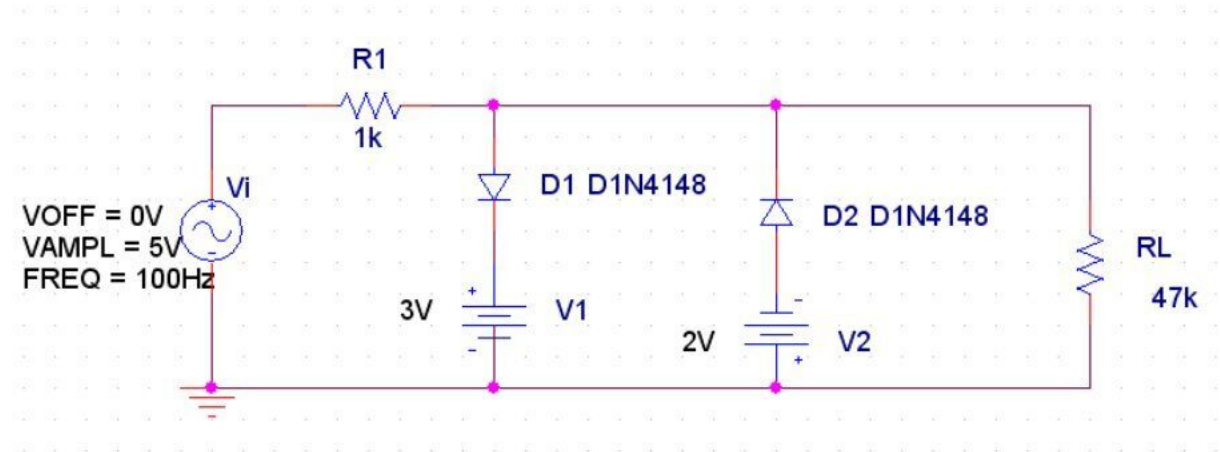


4)

Design Problem: $v_i(t)$ and $v_o(t)$:

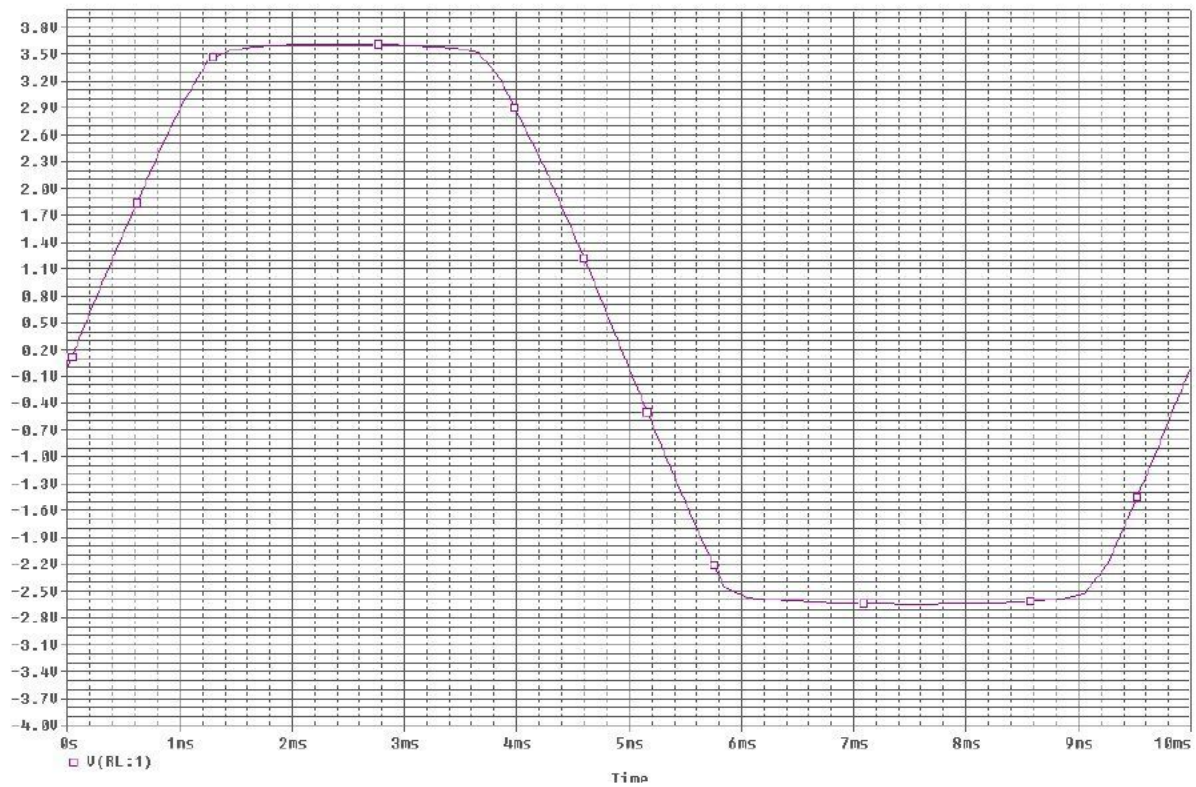
We can see that $v_o(t)$ is clipped at 3.7 Volts and -2.7 Volts. We can use a simple two-diode circuit for this example. Since the diode's voltages are equal to ($V_{D1} = V_{D2} = 0.7$ Volts), we need to DC voltages, one is 3 Volts and the other is 2 Volts.

This circuit is what we need here:



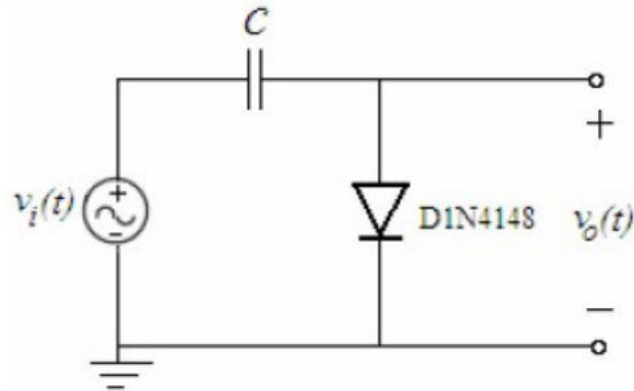
PSPICE simulation graph gives what we are looking for, circuit is correct:

$v_o(t)$



5)

a)



If we analyze the circuit, we will see that for the first quarter (0 – 2.5 ms) , $v_i(t)$ is increasing and C is charging with the value $V_c = V_p$. So at the first quarter, $v_o(t) = V_{diode} = 0.7$ Volts.

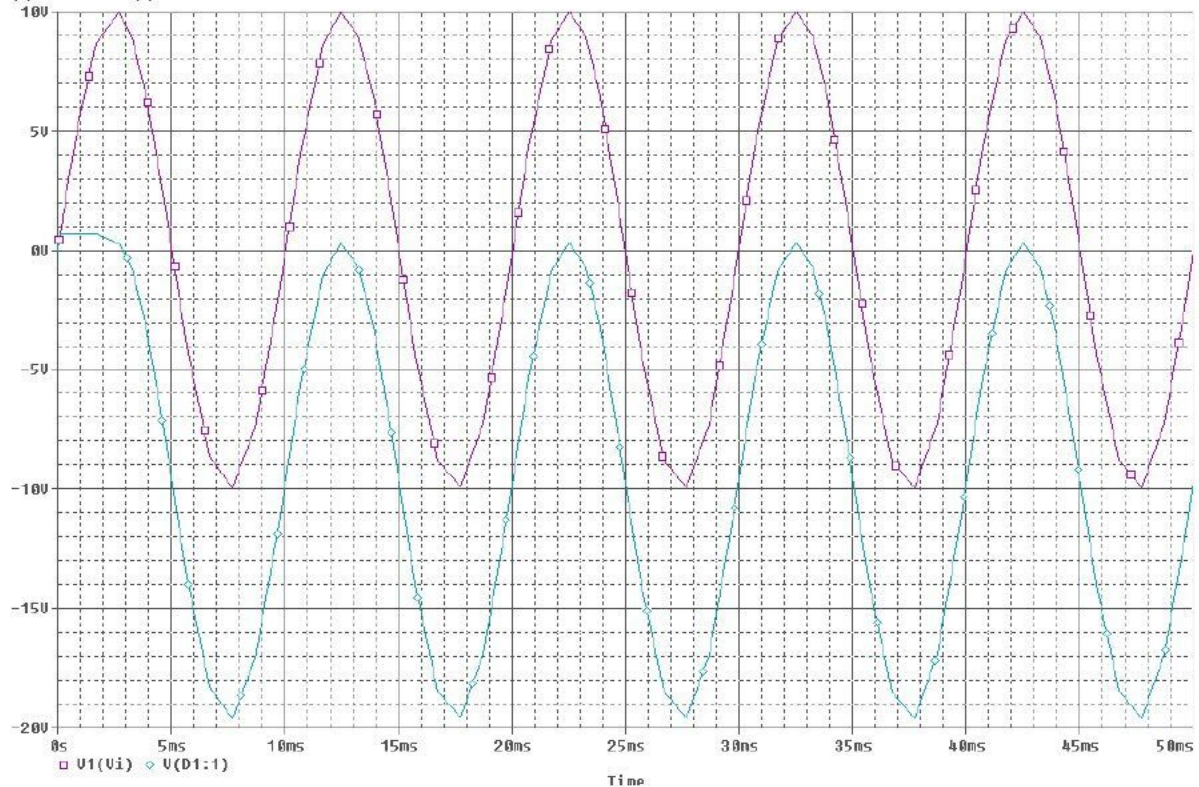
Since there are no resistive elements on this circuit, C will not discharge it's load. So after the first quarter $v_o(t)$ is equal to $-V_c + v_i(t) + V_{diode}$.

Since the output voltage is oscillating around $-V_p + V_{diode} = -10 + 0.7 = -9.3$ Volts, this average value is the DC value of the output:

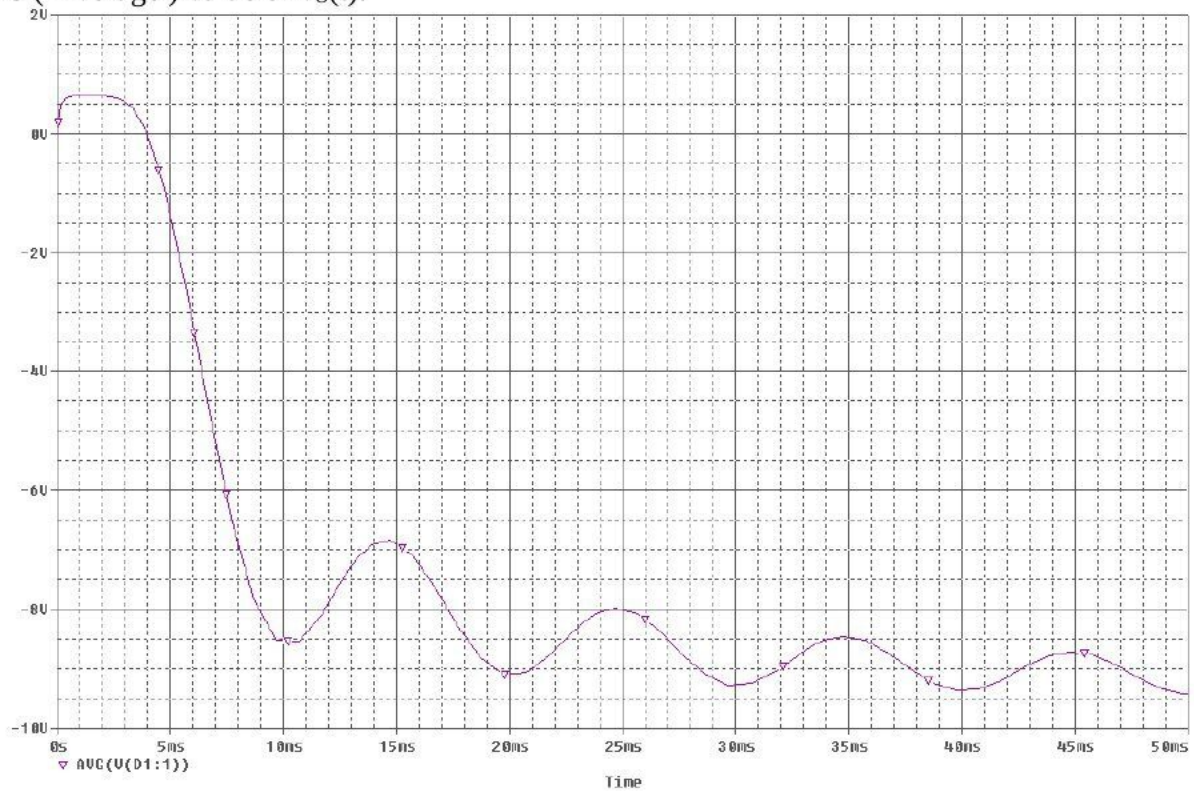
$$\int_T (-10 + v_i(t) + V_{diode}) dt = -10 + V_{diode}$$

(The self-plotted graphs are attached to the end of the document)
(PSPICE generated graphs)

$v_i(t)$ and $v_o(t)$:

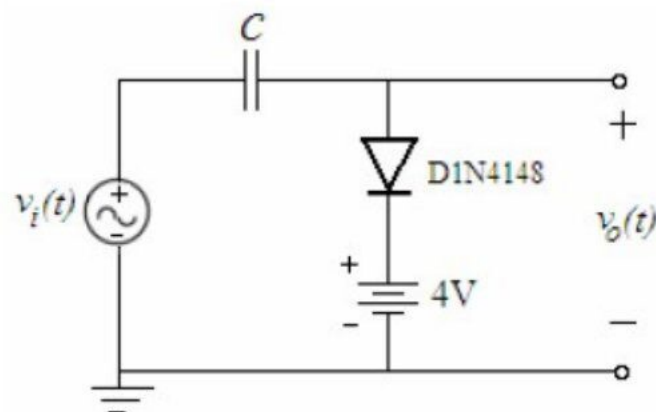


DC (Average) value of $v_o(t)$:



b)

Circuit is:

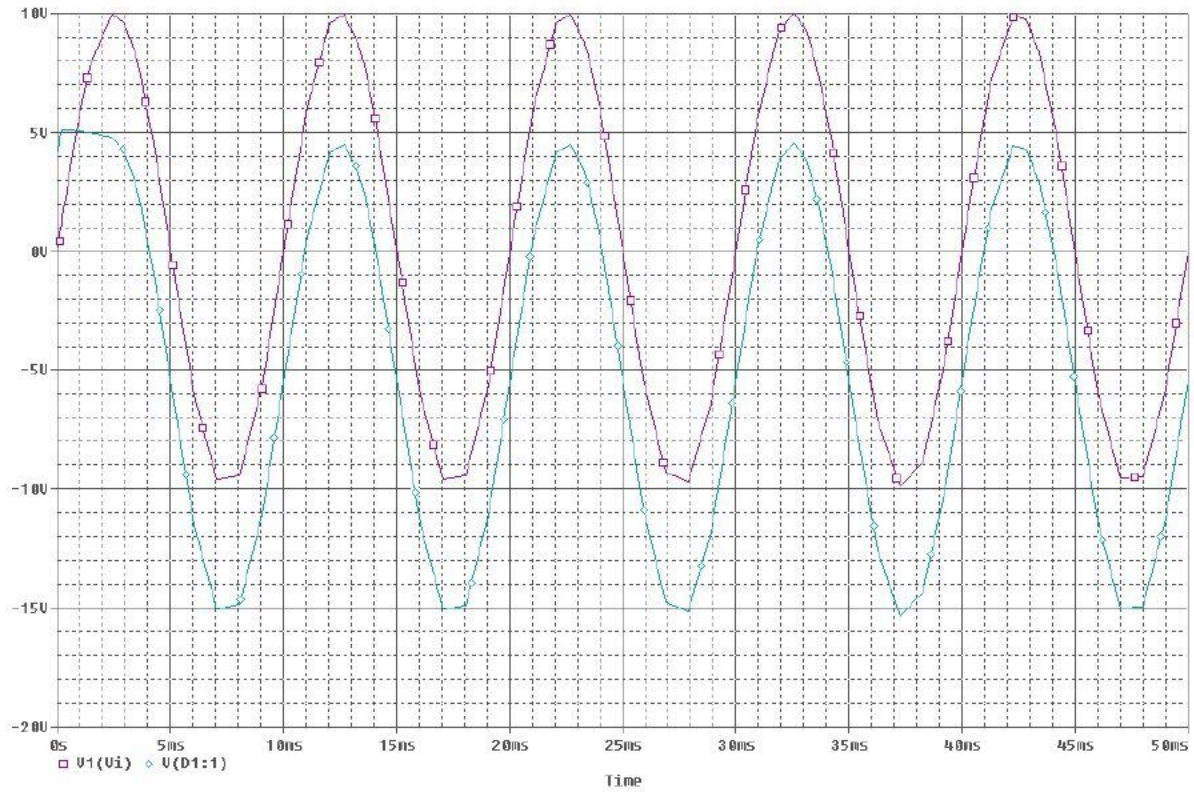


We can see that D1 is off for $v_i(t) < 4 + V_{diode} \Leftrightarrow v_i(t) < 4.7$ Volts . For $v_i(t) > 4.7$ Volts, D1 is on and the maximum voltage between capacitor's terminals happens at $v_i(t) = 10$ Volts, so capacitor is loaded with $V_C = 10 - 4 - 0.7$ Volts = 5.3 Volts.

So for $v_i(t) < 4.7$ Volts, $v_o(t)$ is equal to 4.7 Volts. For $v_i(t) > 4.7$ Volts, D1 is on and $v_o(t)$ becomes $-V_C + v_i(t)$ Volts.

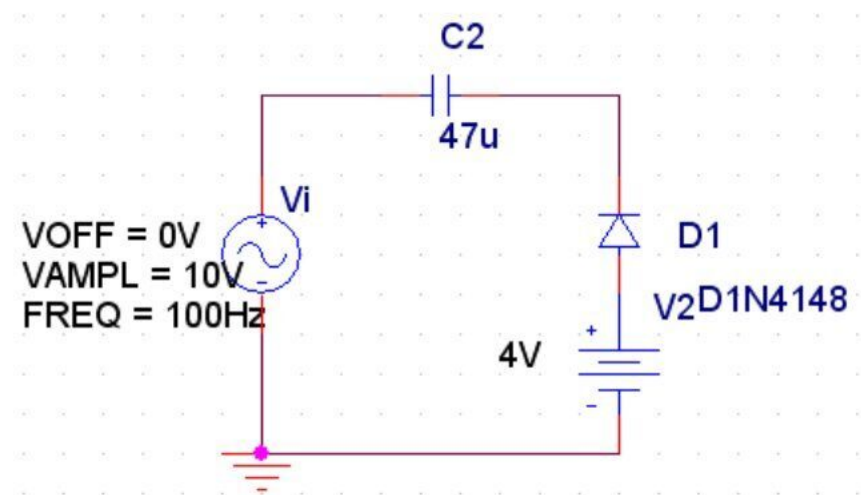
(The self-plotted graphs are attached to the end of the document)
 (PSPICE generated graphs)

$v_i(t)$ and $v_o(t)$:



c)

The circuit becomes:

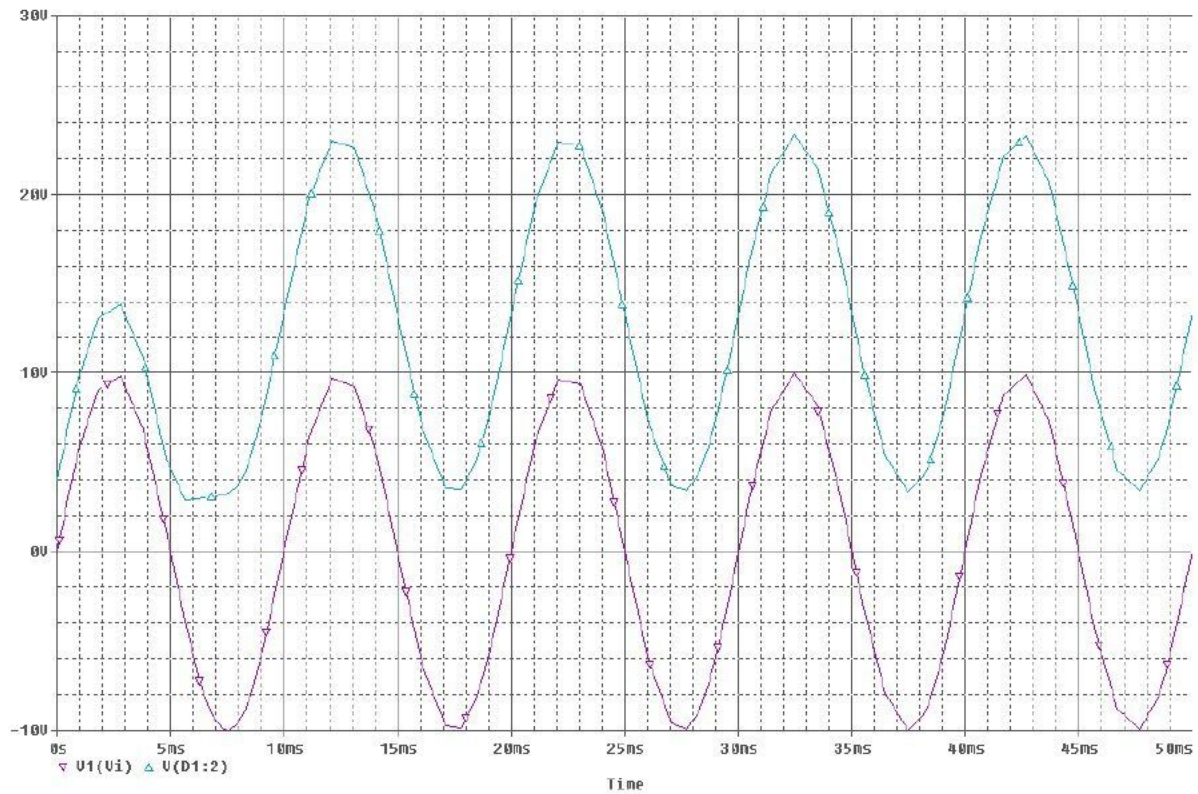


We can see that $D1$ is off for $v_i(t) > -4 + V_{diode} \Leftrightarrow v_i(t) > -3.3$ Volts . Capacitor charges with - 4 Volts.

For $v_i(t) < -4 + V_{\text{diode}}$, D1 is on and Capacitor charges with $-V_p - 3.3 \text{ Volts} = -13.3 \text{ Volts}$ and remains charged with that value. So after capacitor is charged with -13.3 Volts , $v_o(t)$ is equal to $-V_c + v_i(t) \text{ Volts}$.

(The self-plotted graphs are attached to the end of the document)
(PSPICE generated graphs)

$v_i(t)$ and $v_o(t)$:



6)

We know from the datasheet that V_Z for 1N748 is 3.9 Volts. Here, $v_i(t)$ oscillates between $10 + V_p$ and $10 - V_p$ that is between 12 and 8 volts. Since zener diode will always act like a regulator, by kvl, $v_o(t)$ will be:

$$v_o(t) = 10 - v_s(t) - V_Z$$

(The self-plotted graphs are attached to the end of the document)
(PSPICE generated graphs)

$v_i(t)$ and $v_o(t)$:

