Microelectronics Circuit Analysis and Design Homework(4th)

Yuejin Xie U202210333

Sept 15th, 2023

2.14 The circuit in Figure P2.14 is a complementary output rectifier. If $v_s = 26\sin[2\pi(60)t]$V, sketch the output waveforms v_o^+ and v_o^- versus time, assuming $V_\gamma = 0.6$V for each diode.

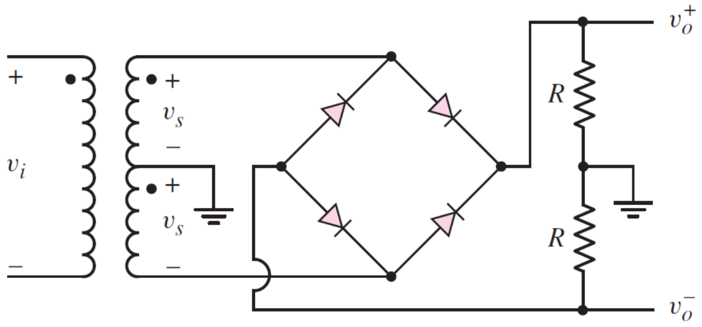


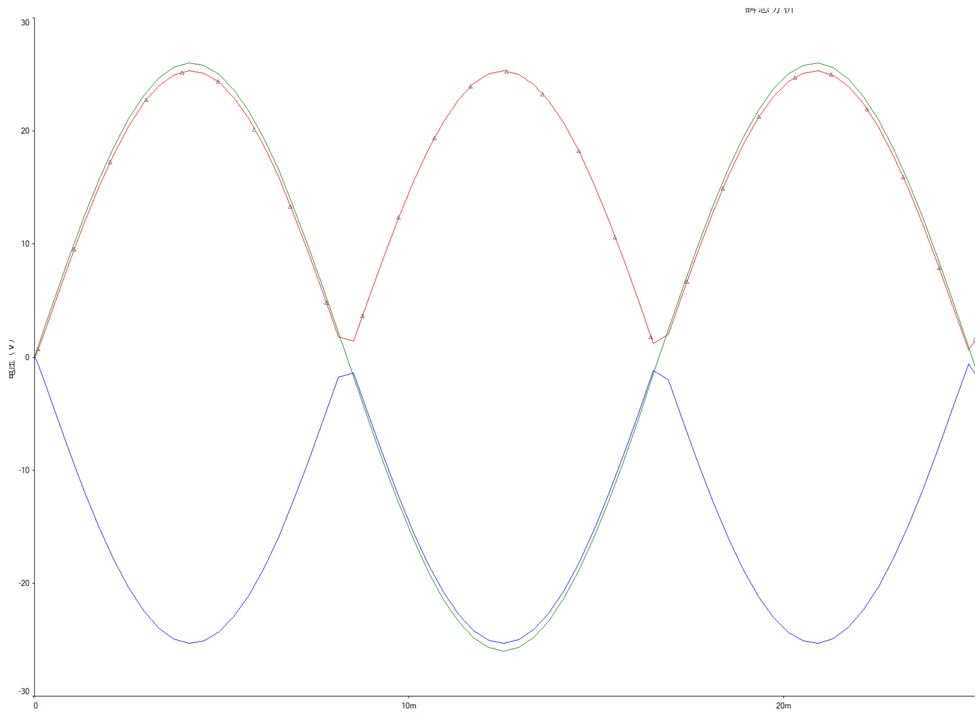
Figure 1: Problem 2.14

Solution:

The four diodes from left to right and top to bottom are numbered A, B, C, and D respectively. When $0 < t \leq \frac{T}{2}$, A, C are conducted and B, D aren't, so at this moment, $v_o^+ = v_s - V_\gamma, v_o^+ = -v_s + V_\gamma$ (conducted, if aren't conducted $v_o^+ = v_o^- = 0$)

When $\frac{T}{2} < t < T$, B, D are conducted and A, C aren't, so at this moment, the answer is the same as $0 < t \leq \frac{T}{2}$

We provide results using Multisim:



2.45 In the circuit in Figure P2.45 the diodes have the same piecewise linear parameters as described in Problem 2.44($V_\gamma = 0.6$V and $r_f = 0$). Calculate the output voltage V_O and the currents I_{D1}, I_{D2}, and I for the following input conditions: (a) $V1 = V_2 = 10$V; (b) $V_1 = 10$V, $V_2 = 0$; (c) $V_1 = 10$V, $V_2 = 5$V; and (d) $V_1 = V_2 = 0$.

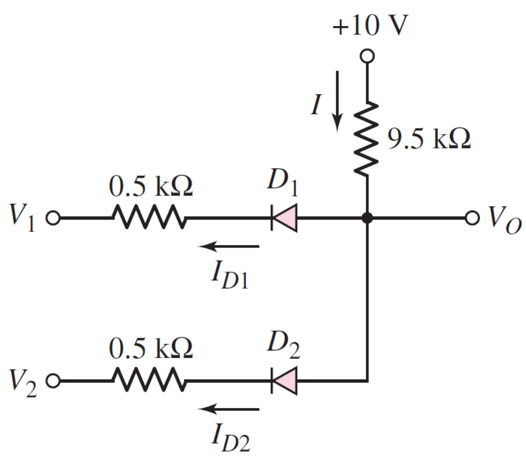


Figure 2: Problem 2.45

Solution:

(a)Owing to $V_s = V_1 = V_2 = 10V$, D_1 and D_2 can't be conducted, so $V_O = V_s = 10$V, $I = I_{D1} = I_{D2} = 0$,

(b)In this case, D_2 is conducted but D_1 not, so $I_{D1} = 0, I_{D2} = I = \dfrac{V_s - V_\gamma}{R_1 + R_2} = 0.94$mA.

$V_O = V_s - IR_1 = 1.07$V

(c)In this case, D_2 is conducted but D_1 not, so $I_{D1} = 0, I_{D2} = I = \dfrac{V_s - V_\gamma}{R_1 + R_2} = 0.44$mA.

$V_O = V_s - IR_1 = 5.82$V

(d)In this case, both D_1 and D_2 are conducted, we have equation:

$$\begin{cases} I = \dfrac{V_s - V_O}{R_1} \\ I = I_{D1} + I_{D2} \\ I_{D1} = I_{D2} = \dfrac{V_O - V_\gamma}{R_1} \end{cases} \Rightarrow \begin{cases} I = 0.964\text{mA} \\ V_O = 0.842\text{V} \\ I_{D1} = I_{D2} = 0.482\text{mA} \end{cases}$$

2.58 (a) Each diode in the circuit in Figure P2.58 has piecewise linear parameters of $V_\gamma = 0$ and $r_f = 0$. Plot v_O versus v_I for $0 \le v_I \le 30$V. Indicate the breakpoints and give the state of each diode in the various regions of the plot. (b) Compare the results of part (a) with a computer simulation analysis.

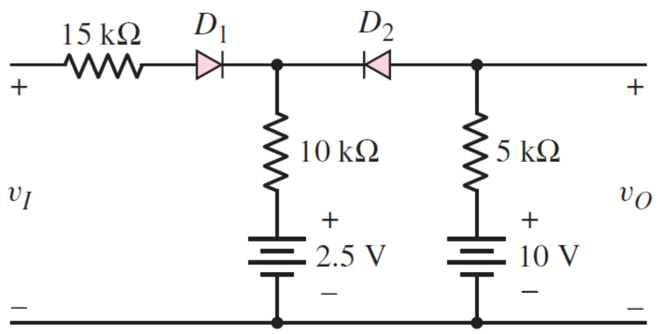


Figure 3: Problem 2.58

Solution:

(a)When $0 < V_I < 2.5$V, D_1 and D_2 aren't conducted, so $V_O = 10$V

When 2.5V$\le V_I < 21.25$V, D_1 is conducted but D_2 not, so $V_O = 10$V

When 21.25V$\le V_I < 30$V, D_1 and D_2 are conducted, we have equation:

$$\frac{V_I - V_O}{15k\Omega} = \frac{V_O - 2.5}{10k\Omega} + \frac{V_O - 10}{5k\Omega}$$
$$\Rightarrow V_O = \frac{2}{11}V_I + \frac{135}{22}$$

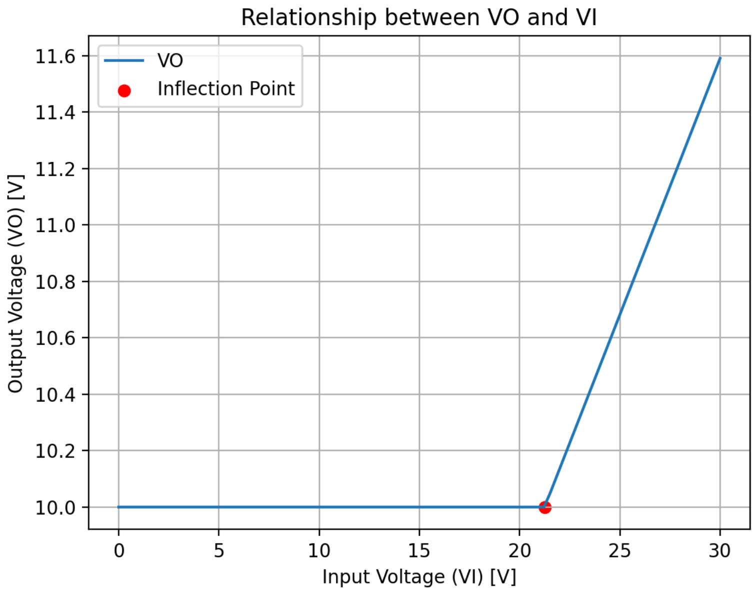


Figure 4: v_O versus v_I for $0 \leq v_I \leq 30$V

(b)

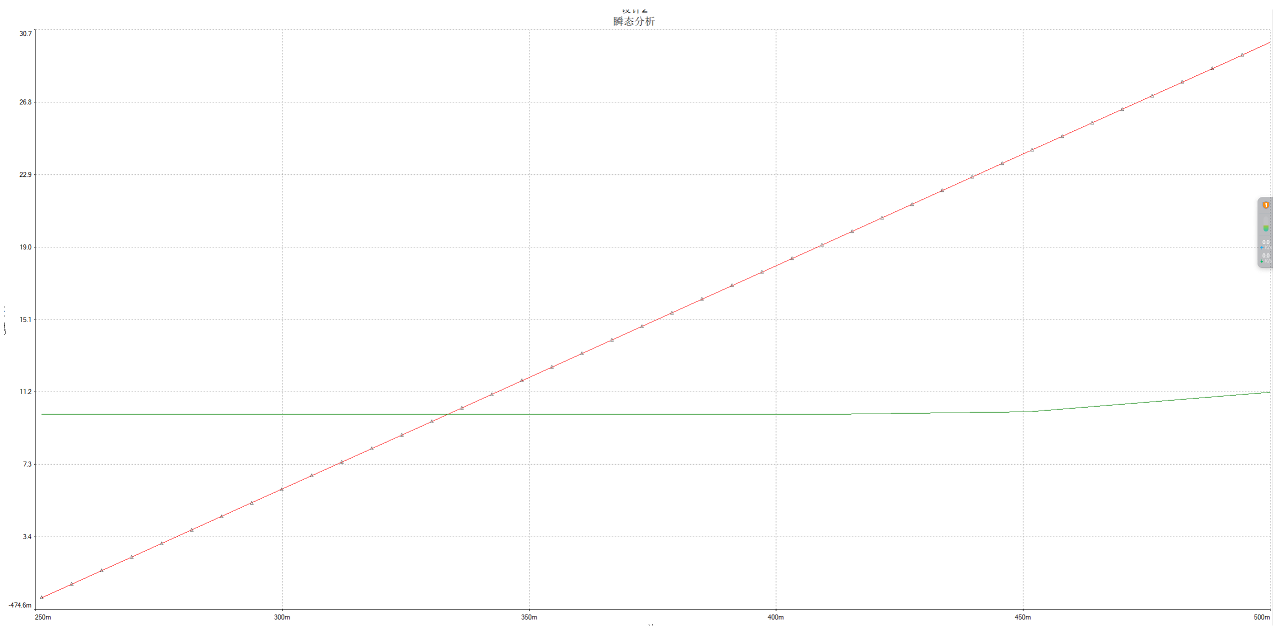


Figure 5: Multisim AAAnalysis