Microelectronics Circuit Analysis and Design Homework(3rd)

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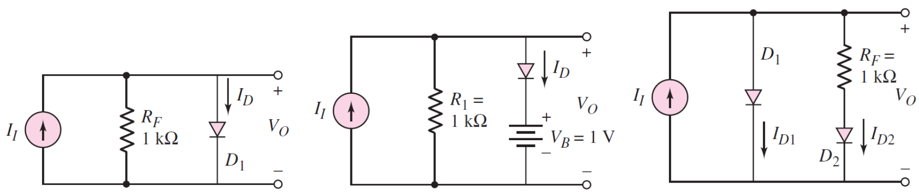
1.45 The diode cut-in voltage is $V_\gamma = 0.7$ V for the circuits shown in Figure P1.45. Plot V_O and I_D versus I_I over the range $0 \le I_I \le 2$mA for the circuit shown in (a) Figure P1.45(a), (b) Figure P1.45(b), and (c) Figure P1.45(c).



(i) a (ii) b (iii) c

Figure 1: (a)

Solution:

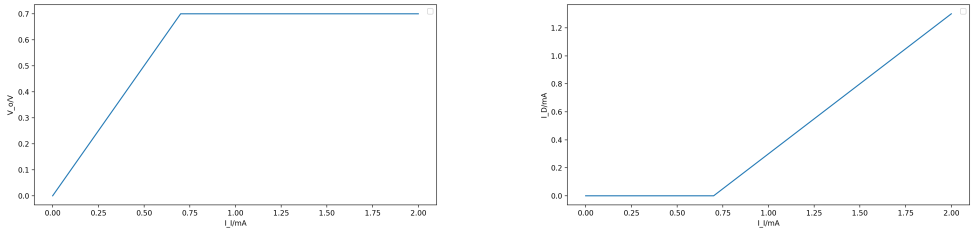
(a)KCL:$I_I = \dfrac{V_O}{R_F} + I_D$

When $V_O \ge V_\gamma = 0.7$V, the diode is conducted, so R_F is shorted $\Rightarrow I_D = I_I - 0.7, V_O = 0.7$V

To satisfy the circumstance, we need $I_I \ge 0.7$mA.

When $V_O \le V_\gamma = 0.7$V, the diode isn't conducted and can be regarded as open$\Rightarrow I_D = 0, V_O = I_I R_F$

To satisfy the circumstance, we need $I_I \le 0.7$mA.



(i) $V_O - I_I$ (ii) $I_D - I_I$

Figure 2: (a)

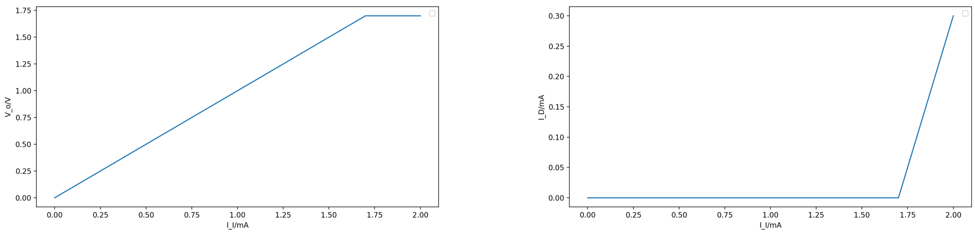
(b)KCL:$I_I = \dfrac{V_O}{R_F} + I_D$

When $V_O \geq V_\gamma + V_B = 1.7$V, the diode is conducted, so R_F is shorted $\Rightarrow I_D = I_I - 1.7, V_O = 1.7$V

To satisfy the circumstance, we need $I_I \geq 1.7$mA.

When $V_O \leq V_\gamma + V_B = 1.7$V, the diode isn't conducted and can be regarded as open$\Rightarrow I_D = 0, V_O = I_I R_F$

To satisfy the circumstance, we need $I_I \leq 1.7$mA.

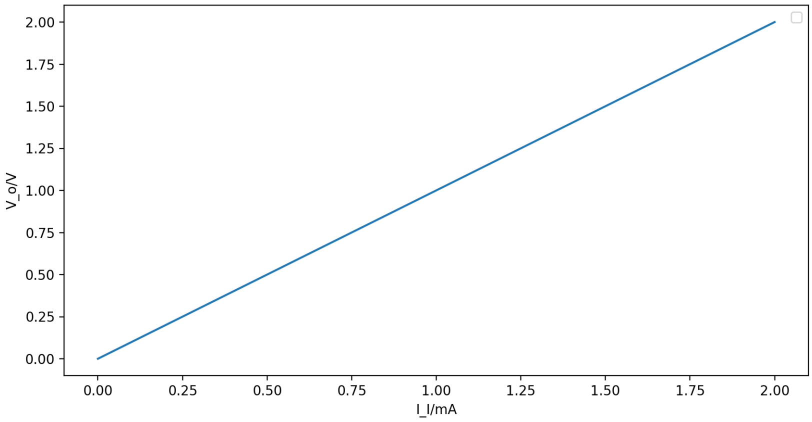


(i) $V_O - I_I$ (ii) $I_D - I_I$

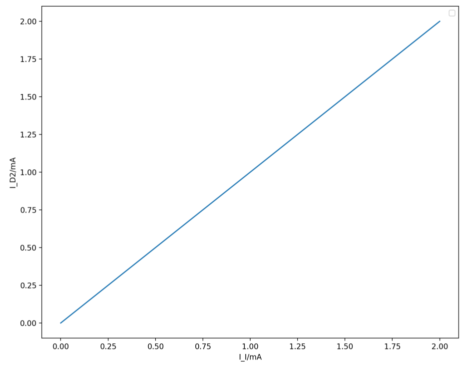
Figure 3: (b)

(c) We can know that D_1 will be conducted forever(ideal Current Source), and at this time D_2andR_F will be shorted.

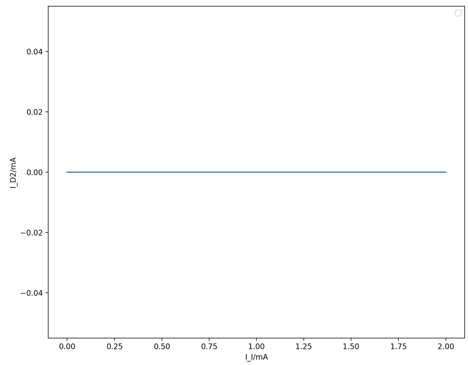
$\Rightarrow V_O = 0.7V, I_{D1} = I_I$ and $I_{D2} = 0$



(i) $V_O - I_I$



(ii) $I_{D1} - I_I$



(iii) $I_{D2} - I_I$

Figure 4: (a)

1.50 Assume each diode in the circuit shown in Figure P1.50 has a cut-in voltage of $V_\gamma = 0.65$V. (a) The input voltage is $V_I = 5$V. Determine the value of R1 required such that ID1 is one-half the value of I_{D2}. What are the values of I_{D1} and I_{D2}? (b) If $V_I = 8V$ and $R_1 = 2k\Omega$, determine I_{D1} and I_{D2}.

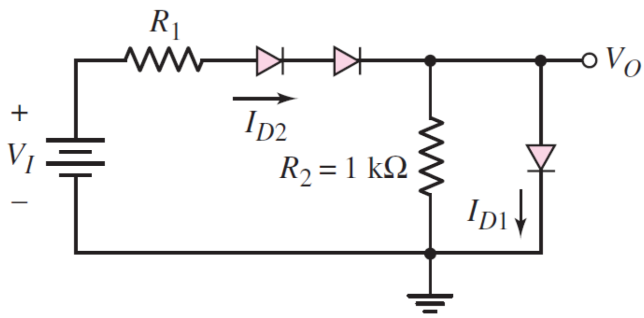


Figure 5: Problem 1.50

Solution:

(a)Actually, we can know that D_1 and D_2 are conducted, so we have equation:

$$\begin{cases} V_O = V_\gamma \\ I_{D1} = \dfrac{1}{2} I_{D2} \\ V_I - V_O = I_{D2}R_1 + 2V_\gamma \\ I_{D2} = \dfrac{V_O}{R_2} + I_{D1} \end{cases} \Rightarrow \begin{cases} R_1 = 1.56k\Omega \\ I_{D2} = 1.3\text{mA} \\ I_{D1} = 1.95\text{mA} \end{cases}$$

(b)We assume D_1 and D_2 are conducted, so we have equation

$$\begin{cases} V_O = V_\gamma \\ V_I - V_O = I_{D2}R_1 + 2V_\gamma \\ I_{D2} = \dfrac{V_O}{R_2} + I_{D1} \end{cases} \Rightarrow \begin{cases} I_{D1} = 3.025\text{mA} \\ I_{D2} = 2.375\text{mA} \end{cases}$$

1.57 Consider the Zener diode circuit shown in Figure P1.57. The Zener breakdown voltage is $V_Z = 5.6$V at $I_Z = 0.1$mA, and the incremental Zener resistance is $r_z = 10\Omega$. (a) Determine V_O with no load$(R_L = \infty)$. (b) Find the change in the output voltage if V_{PS} changes by ± 1V. (c) Find V_O if V_{PS} = 10V and $R_L = 2k\Omega$.

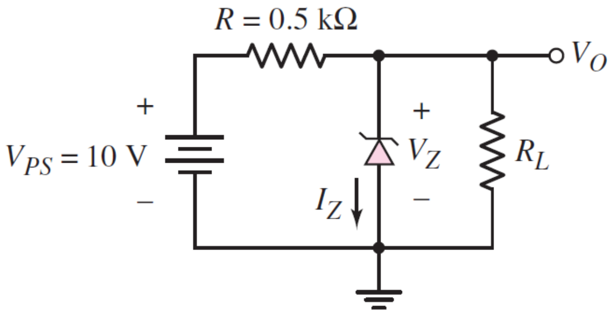


Figure 6: Problem 1.57

Solution:

(a)Because of KCL and information provided by problem:

$$\frac{V_{PS}-V_O}{R} = \frac{V_O-V_z}{r_z} \Rightarrow V_O = 5.686\text{V}$$

(b)When $V_{PS} = 9$V:

$$\frac{V_{PS}-V_O}{R} = \frac{V_O-V_z}{r_z} \Rightarrow V_{O1} = \frac{17}{3}\text{V}$$

When $V_{PS} = 11$V:

$$\frac{V_{PS}-V_O}{R} = \frac{V_O-V_z}{r_z} \Rightarrow V_{O2} = \frac{97}{17}\text{V}$$

$$\Rightarrow \Delta V_O = V_{O1} - V_{O2} = 0.0392\text{V}$$

(c)Because of KCL and information provided by problem, we have equation:

$$\frac{V_{PS}-V_O}{R} = \frac{V_O-V_Z}{r_z} + \frac{V_O}{R_L} \Rightarrow V_O = 5.659\text{V}$$