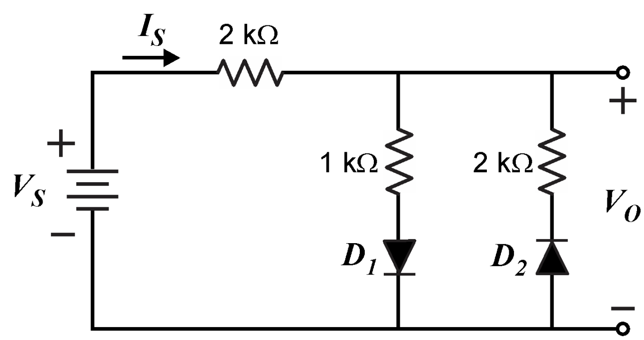
1) ***Diode Transfer Characteristics***: if V_S is varied over the range $-3V \le V_S \le +3V$, plot the transfer characteristic for V_O (y-axis) versus V_S (x-axis). Hand drawn plots are acceptable.

   When the diode is ON, use the "constant-voltage drop model" with $V_{D,ON}$ = 0.7 V.

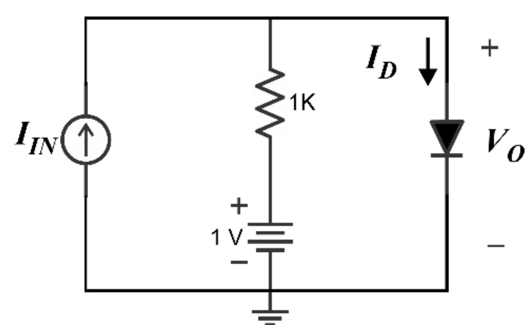


2) ***Diode Transfer Characteristics***: Using a **PSpice** simulator, such as CircuitLab, simulate the transfer characteristics for V_O (y-axis) versus V_S (x-axis) using the circuit in Problem #1. Simulate a DC sweep with V_S varied over the range $-3V \le V_S \le +3V$. The PSpice diode can be the 1N4148 or equivalent. Submit your PSpice schematic and the simulated plot of the transfer characteristics. Comment on your hand calculated solutions in comparison to the simulated

3) ***Diode Transfer Characteristics***: if I_{IN} is varied over the range $0 \le I_{IN} \le 2mA$, plot the transfer characteristic for the following (hand drawn plots are acceptable).
   When the diode is ON, use the "constant-voltage drop model" with $V_{D,ON}$ = 0.7 V.

   a. V_O (y-axis) versus I_{IN} (x-axis)

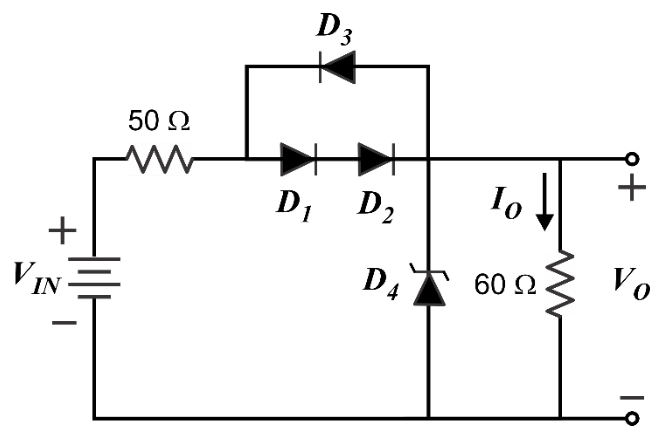
   b. I_D (y-axis) versus I_{IN} (x-axis).



4) ***Diode/Zener Transfer Characteristics***: if V_{IN} is varied over the range $-10 \le V_{IN} \le +10V$, plot the transfer characteristic for the following (hand drawn plots are acceptable). When the diode is ON (forward biased region), use the "constant-voltage drop model" with $V_{D,ON}$ = 0.7 V. Diodes D1, D2 and D3 are all the same type. Diode D4 is a Zener with V_Z = 3V.

   a. V_O (y-axis) versus V_{IN} (x-axis)

b. I_O (y-axis) versus V_{IN} (x-axis)



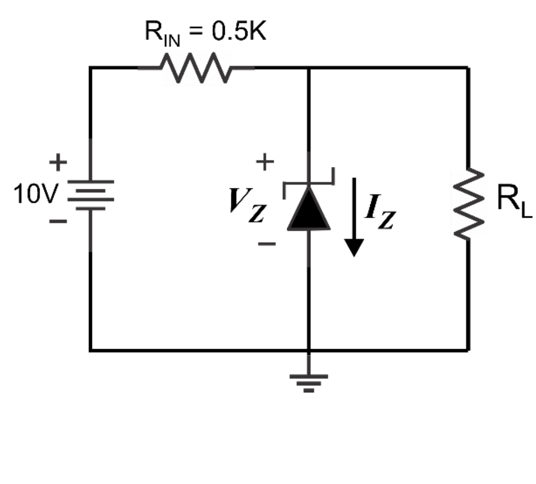
5) ***Zener Diode Analysis***: Knowing that the Zener was selected for a breakdown of V_Z = +6.8V, answer the following questions. Also note that the Zener is rated for a maximum power dissipation of 500 mW ($P_{Z,\ MAX}$ = 500 mW).

a. Determine I_Z with R_L= infinite

b. Calculate the power dissipation, P_Z in the Zener diode with R_L= infinite. Does this value exceed the specified maximum power dissipation for the Zener?

c. Find R_L such that I_Z is 10% of the value of I_Z found in (a).

d. If R_L= 0.1 kΩ, what is the minimum value for R_{IN} such that the Zener diode does not exceed the rated power dissipation of 500 mW ($P_{Z,\ MAX}$)?



Solutions:

① D_1 will be on when $V_s > 0.7V$

$0.7 < V_s < 3$

$I_s = \frac{V_s - 0.7}{2+1}$ mA $= \frac{V_s - 0.7}{3}$ mA

$V_o = 0.7 + I_s \times 1 = 0.7 + \frac{V_s - 0.7}{3}$

when, $-3 < V_s < -0.7$

$I_s = \frac{-V_s + 0.7}{4}$ mA

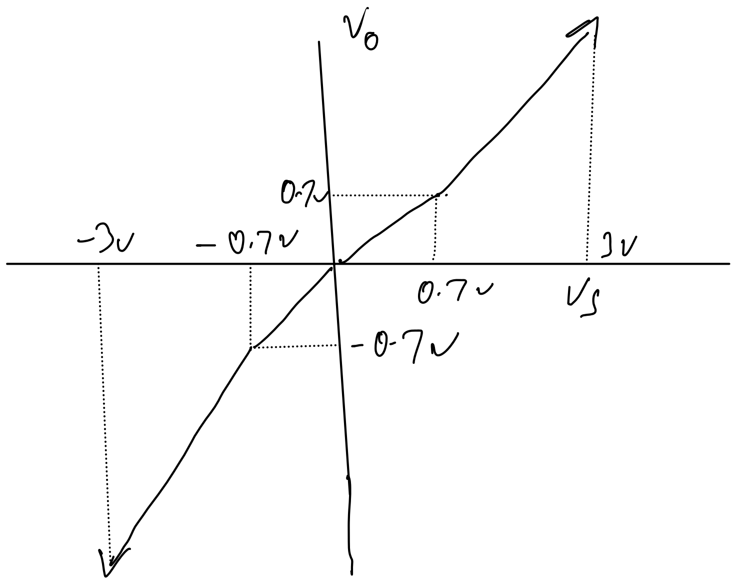
$V_o = -(0.7 + 2 \times I_s) = -\left(0.7 + 2 \times \frac{V_s + 0.7}{4}\right) V$

When $-0.7 < V_s < 0.7$

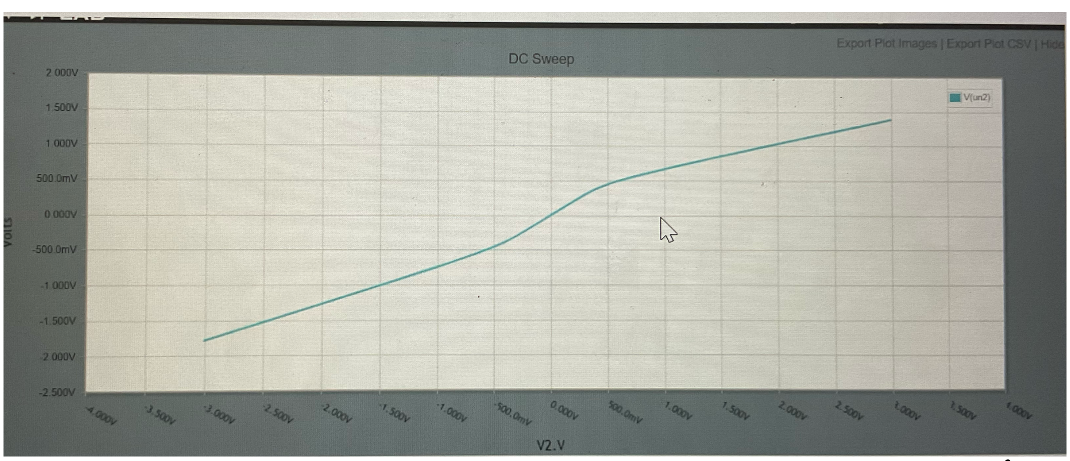
D_1 and D_2 will be off

Hence

$V_o = V_s$



②



They are the same as my calculations.

(3) $0 \le I_{IN} < 2mA$

$V_0 = 0.7V$

$\frac{V_0 - 1}{1K} + I_D = I_{IN}$

(4) V_0 (y) vs I_{IN} (x)

$I_{IN} = 0$

$\frac{V_0 - 1}{1K} + I_D = 0$

$V_0 - 1 = -I_D(1K)$

$V_0 = -I_D(1K) + 1$

$I_{IN} = 1$

$V_D - 1 + I_D = (1K)$

$V_D - 1 = 1K - I_D(1K)$

$V_D = 1K - I_D(1K) + 1$

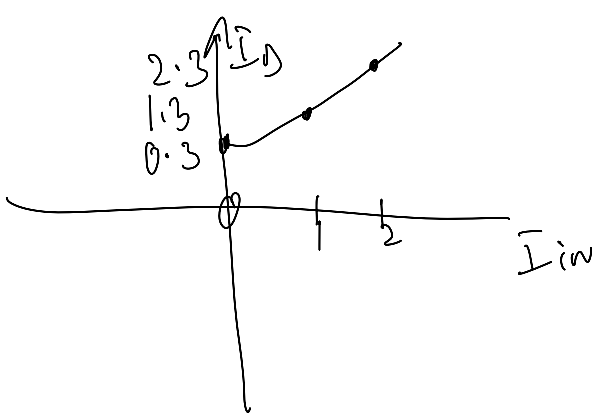
$V_D \Rightarrow (1 - I_D)1K + 1$

depends on I_D

diode is off $V_D = 0$, $I_D = 0$

diode is on $V_D = 0.7$, $V_D = 0.7$

(5)



$\frac{V_D - 1}{1K} + I_D = I_N$

when diode is on

$\frac{0.7 - 1}{1K} + I_D = I_{in}$

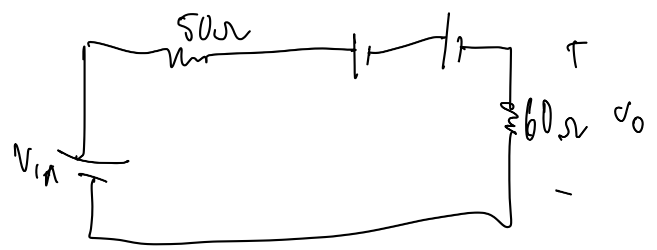
$I_{in} = 0$, $I_D = 0.3mA$
$I_{in} = 1mA$, $I_D = 1.3mA$
$I_{in} = 2mA$, $I_D = 2.3mA$

when diode is off

$\frac{0-1}{1k} + I_D = I_{in}$ $I_D = 0$

(4) $0 < V_{in} < 1.4V$

D_1, D_2 forward bias but blocking mode $V_o = 0V$
$1.4V < V_{in} < 3V$ D_1 and D_2 forward conduction mode



$V_o = (V_{in} - 1.4)\frac{60}{110}$

$V_o = 3V$

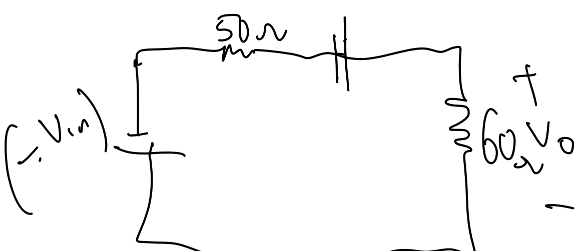
$3V = (V_{in} - 1.4)\frac{60}{110} \Rightarrow V_{in} = 6.9V$

$\therefore 0 < V_{in} < 1.4V \Rightarrow V_o = 0$
$1.4 < V_{in} < 6.9V \Rightarrow 0 < V_o < 3V$
$6.9V < V_{in}$ $V_o = 3V$

$I = 0$
$0 < I_o < 50mA$
$I_o = 50mA$

Owing (0 to -10V)

0 to -0.7V
-0.7 to -1.4V



$V_o = \frac{-V_{in} + 0.7}{110} \times 60$

When $V_0 = -0.7$

$$-0.7 = \frac{-V_{in} + 0.7}{110} \times 60$$

$$V_{in} = -1.9833$$

$\underline{V_{in}}$

0 to -0.7 ⟹ $V = 0$

0.7 to -1.9833 $V = 0$ to $0.7V$

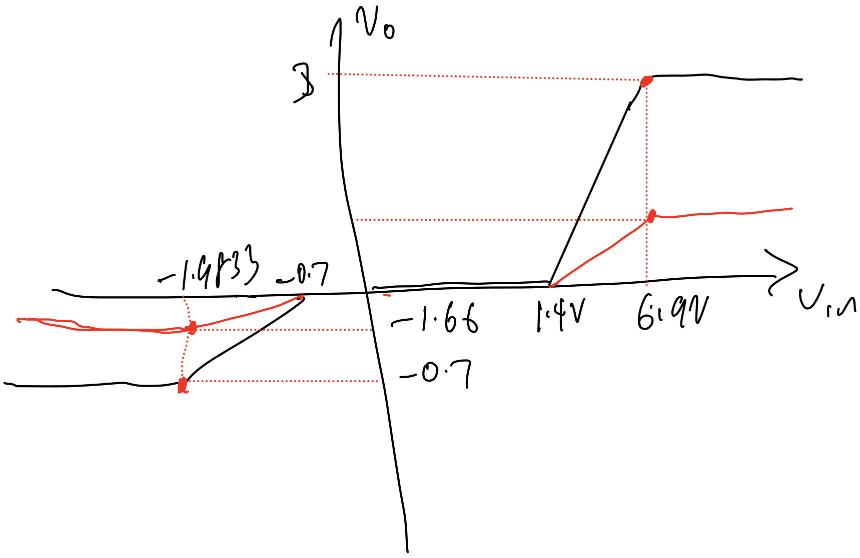
0.7 to -10 $V = -0.7V$

$I_o = 0$

$I_o = 0$ to $-1.166\,mA$

$I_o = -1.166\,mA$

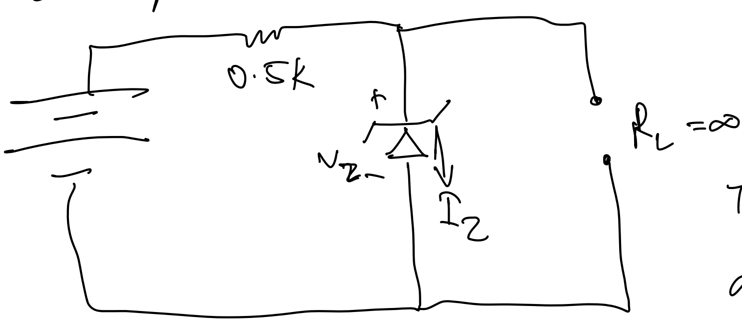
$$I_o = \frac{V_o}{60}$$



(5) $V_z = 6.8V$

$P_{z\,max} = 500mW$

(a) R_L = infinite



The zener diode will break down

$$I_z = \frac{10 - V_z}{0.5k}$$

$$I_z = \frac{10 - 6.8}{0.5k} = 6.4\,mA$$

(b) $P_z = V_z I_z = 6.8 \times 6.4 \times 10^{-3} = 43.52\,mW$ and $P_{z\,max} = 500\,mW$

$\therefore$ Not exceeding the specified power dissipation

(c) $I_L = 6.4 \times 10^{-3} \times \frac{10}{100} = 0.64\,mA$

$$I = \frac{6.8}{R_L} + 0.64 \times 10^{-3}$$

Now,

$$10 - I(0.5 \times 10^3) = 6.8$$

$$= \left(\frac{6.8}{R_L} + 0.64 \times 10^{-3}\right)\left(0.5 \times 10^3\right) = 3.2$$

$$= \frac{3.4 \times 10^3}{R_L} = 0.32 = 3.2$$

$$= R_L = 1.18\,k\Omega$$

(d) $V_z I_z < 500\,mW$

$$I_z < \frac{500}{6.8}\,mA$$

$$I_z < 73.52\,mA$$

$$I_z = \frac{6.8}{R_L} = \frac{6.8}{0.1}\,mA = 68\,mA$$

$$\Rightarrow \frac{10 - 6.8}{R_{in}} < (I_z + I_L)$$

$$= \frac{3.2}{R_{in}} < (73.52 + 68)\,mA$$

$$= R_{in} > \frac{3.2}{141.52}\,mA$$

$$\Rightarrow R_{in} > 22.61\,\Omega$$