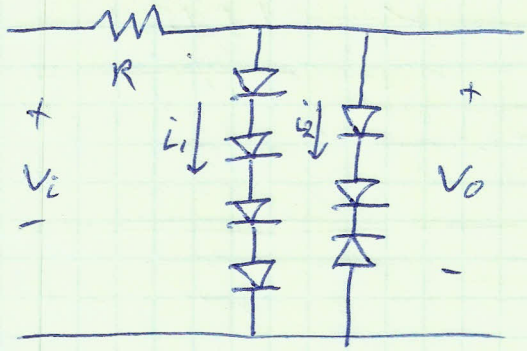
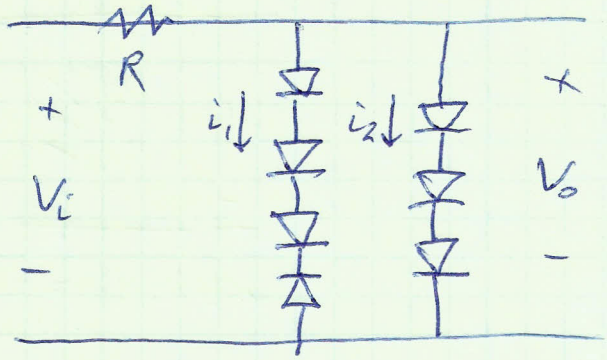
ECE65 | Quiz 1

Question 1



or



$i_2 = 0$ always

$i_1 = 0$ always

The branch with opposed diodes will always have $i = 0$
The other branch with n diodes ($n = 3$ or 4)
will either have all diodes ON or all diodes OFF
Voltage drop across this branch in the ON state will be $V_o = nV_{DO}$

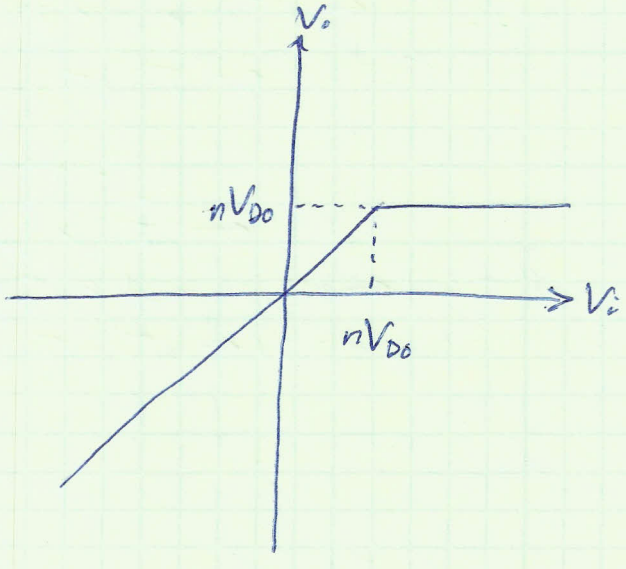
Transfer function

$V_i < nV_{DO} \rightarrow V_o = V_i$

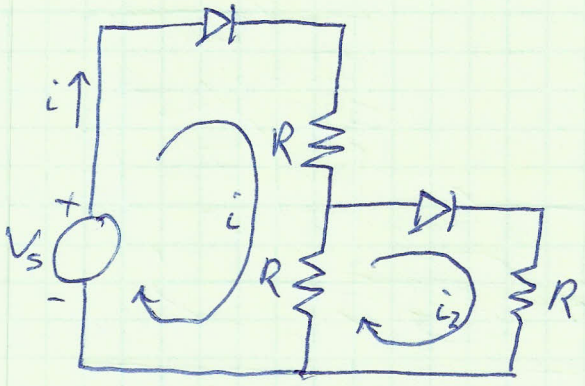
$V_i \geq nV_{DO} \rightarrow V_o = nV_{DO}$

$nV_{DO} = 2.8\,V$ for test 1

$nV_{DO} = 2.1\,V$ for test 2



Question 2



Assume both diodes ON

$$V_s - V_{DO} - Ri - R(i - i_2) = 0$$

$$V_{DO} + Ri_2 + R(i_2 - i) = 0$$

$$V_s - V_{DO} - 2Ri + Ri_2 = 0$$

$$V_{DO} + 2Ri_2 - Ri = 0$$

$$i_2 = \frac{Ri - V_{DO}}{2R}$$

$$V_s - V_{DO} - 2Ri + \tfrac{1}{2}Ri - \tfrac{1}{2}V_{DO} = 0$$

$$V_s - \tfrac{3}{2}V_{DO} - \tfrac{3}{2}Ri = 0$$

$$i = \frac{\frac{3}{3}V_s - V_{DO}}{R}, \quad i_2 = \frac{\frac{1}{3}V_s - V_{DO}}{R}$$

$i > 0$ if $V_s > \frac{3}{2}V_{DO}$, $i_2 > 0$ if $V_s > 3V_{DO}$

so both diodes are in the ON state

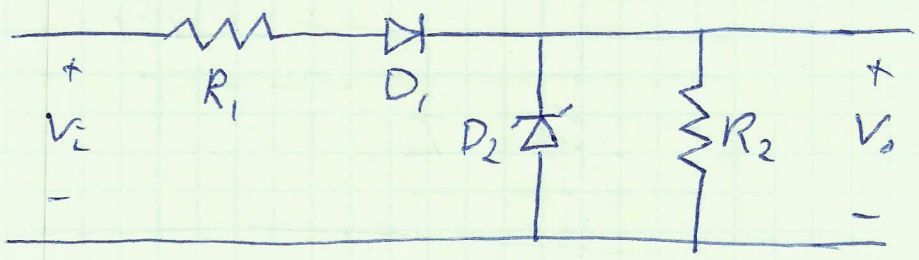
test 1

$i = 5.3\,mA$

test 2

$i = 3.3\,mA$

Question 3



For $V_i < V_{D0}$, both diodes OFF, $V_o = 0V$

When $V_i > V_{D0}$, D1 turns on,

$$V_i - iR_1 - V_{D0} - iR_2 = 0$$

$$i = \frac{V_i - V_{D0}}{R_1 + R_2} \quad \text{(note: } i > 0 \text{ for } V_i > V_{D0}\text{)}$$

$$V_o = iR_2 = \frac{R_2}{R_1 + R_2}(V_i - V_{D0})$$

When $V_o \geq V_z$, D2 enters Zener region, holds V_o at V_z

$$V_o = \frac{R_2}{R_1 + R_2}(V_i - V_{D0}) = V_z$$

$$V_i = \frac{R_1 + R_2}{R_2} V_z + V_{D0}$$

Transfer function: (test 1)

$V_i < 0.7V \rightarrow V_o = 0V$

$0.7V < V_i < 10.7V \rightarrow V_o = \frac{1}{2}(V_i - 0.7V)$

$V_i > 10.7V \rightarrow V_o = 5V$

Test 2

$V_i < 0.7V \rightarrow V_o = 0V$

$0.7V < V_i < 16.7V \rightarrow V_o = \frac{1}{4}(V_i - 0.7V)$

$V_i > 16.7V \rightarrow V_o = 4V$