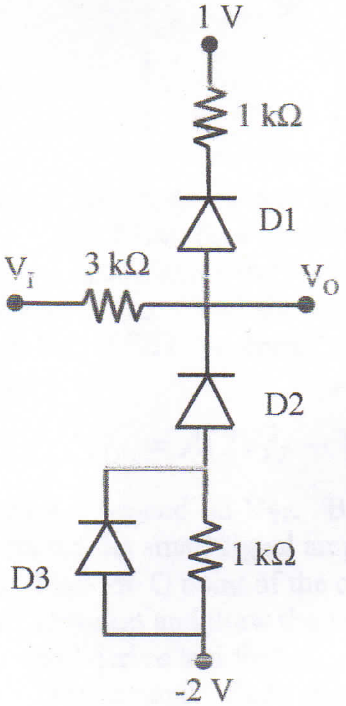
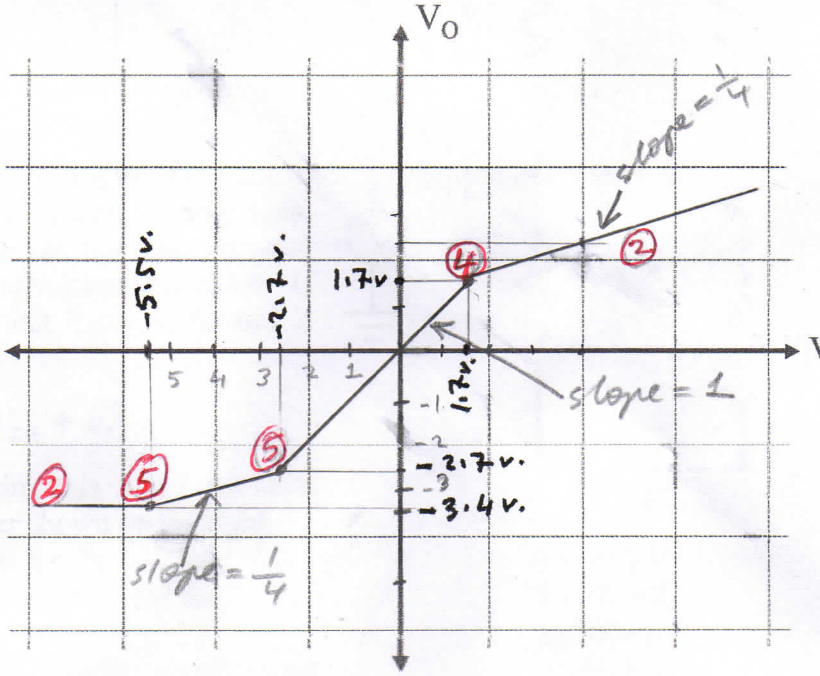
1. (20 points)

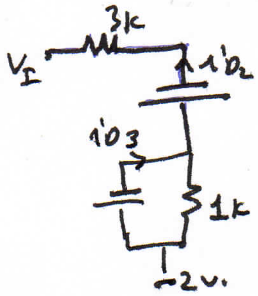
For the below circuit, the diodes are ideal with a turn on voltage of V_{ON}=0.7V. Find and plot V_O vs V_I for -8V < V_I < 8V in the provided graph template. Calculate and clearly indicate all critical voltage values and verify the states of the diodes.

Hint: When V_I = -8V, assume D1 is OFF, and D2 and D3 are ON. D3 turns of when I_{D3}<0.





$V_I = -8v$



$i_{D_2} = \frac{-2-0.7-0.7-(-8)}{3k} = 1.53\ mA > 0$ ✓ 2

$i_{D_3} = i_{D_2} - \frac{0.7}{1} = 1.53 - 0.7 = 0.83\ mA > 0$ ✓

As V_I is increased D3 turns OFF

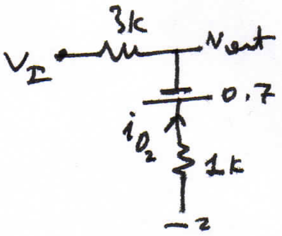
when $i_{D_3} = 0 = \frac{-2-0.7-0.7-V_I}{3} - 0.7$

$0 = \frac{-3.4-V_I}{3} - 0.7 \Rightarrow V_I = -3.4-2.1 = -5.5v.$

$V_I = -5.5 \Rightarrow i_{D_2} = \frac{-3.4-(-5.5)}{3} = 0.7\ mA > 0$ ✓

$V_{out} = -2-0.7-0.7$
$= -3.4v.$

$V_I > -5.5$



$i_{D_2} = \frac{-2-0.7-V_I}{4}$
$= \frac{-2.7}{4} - \frac{V_I}{4}$

$V_{out} = V_I + 3\left(\frac{-2.7}{4} - \frac{V_I}{4}\right)$
$= \frac{V_I}{4} - 2.025$

This continues until $I_{D_2} = 0$

$0 = \frac{-2.7}{4} - \frac{V_I}{4}$

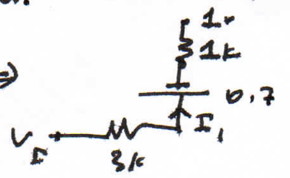
$\Rightarrow V_I = -2.7$

when $V_{out} = \frac{-2.7}{4} - 2.025$
$= -2.7$

$V_I > -2.7$ D_2, D_3 and D_1 are OFF

$V_{OUT} = V_I$ until $V_I = 1+0.7 = 1.7$

$V_I > 1.7 \Rightarrow$



$I_1 = \frac{V_I - 0.7 - 1}{4} = \frac{V_I}{4} - \frac{1.7}{4}$

$V_{out} = V_I - 3\left(\frac{V_I}{4} - \frac{1.7}{4}\right)$
$= \frac{V_I}{4} + 1.275$

e.g. $V_I = 4 \Rightarrow V_{out} = 2.275v.$

($V_I = 8 \Rightarrow V_{out} = 3.275v$)

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