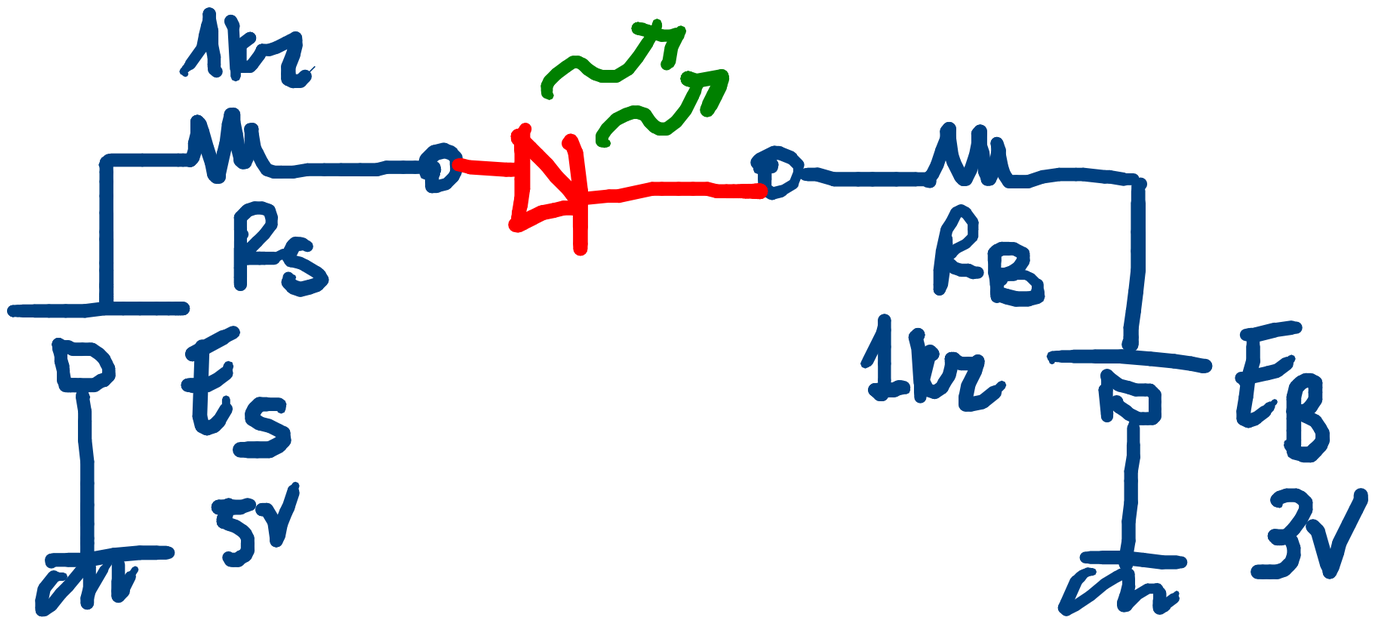
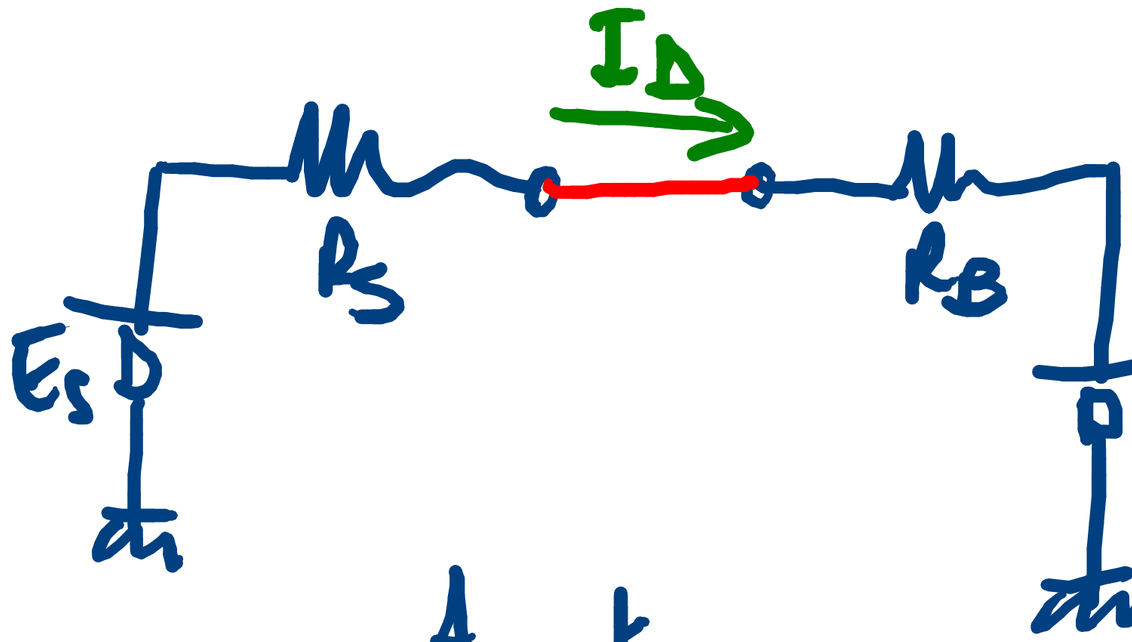
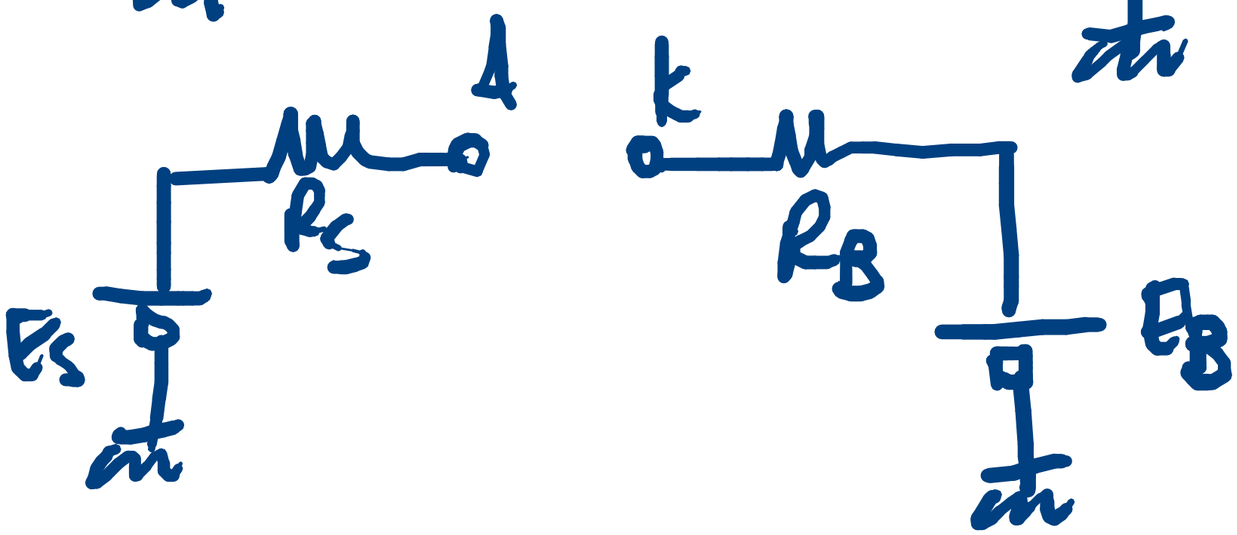




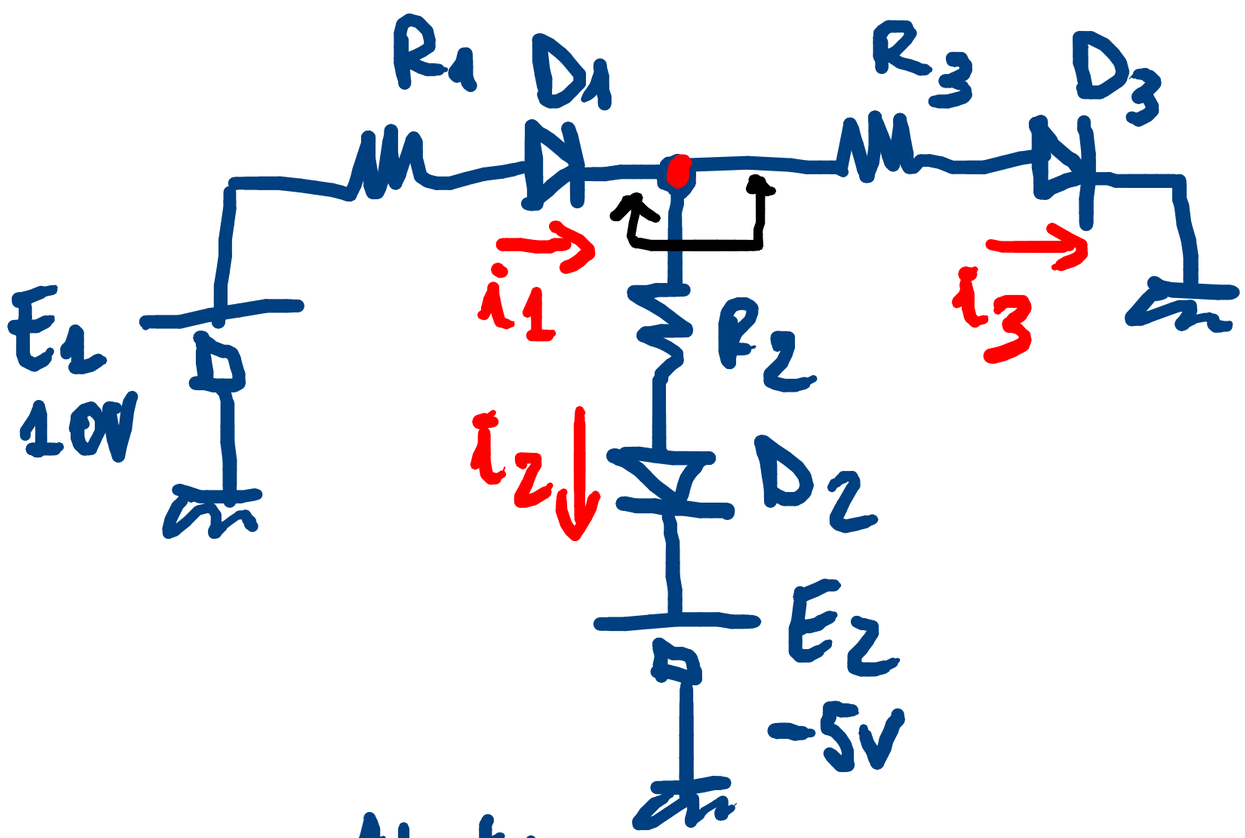
$$I_D = \frac{E_S - E_B}{R_S + R_B} = 1mA$$

$I_D > 0$



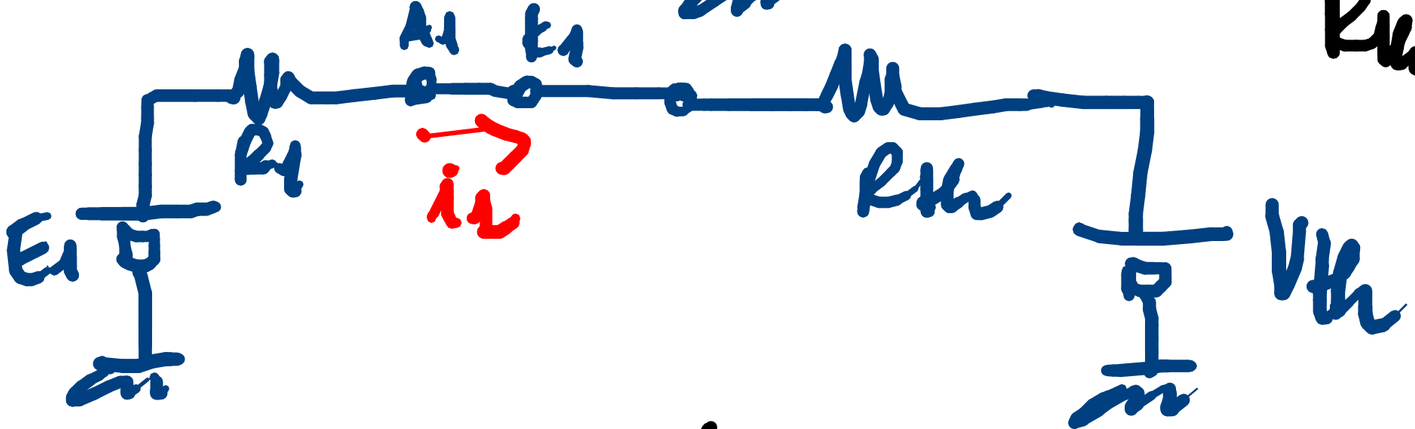
OFF: $V_{AK} < 0$

$$V_{AK} = V_A - V_K = E_S - E_B = 2V \geq 0$$



$R_1 = R_2 = R_3 = 1k\Omega$

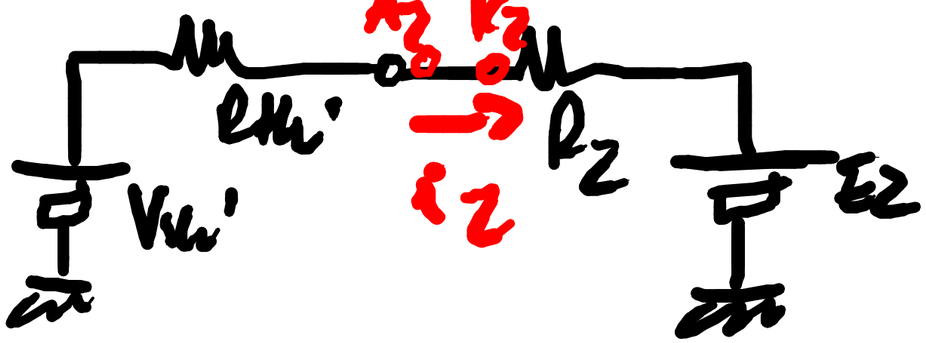
$V_{\gamma i}\ \forall i = 1..3 = 0V$



$R_{Th} = R_2 // R_3$

$V_{Th} = \dfrac{E_2 R_3}{R_2 + R_3}$

$i_1 = \dfrac{E_1 - V_{Th}}{R_1 + R_{Th}}$

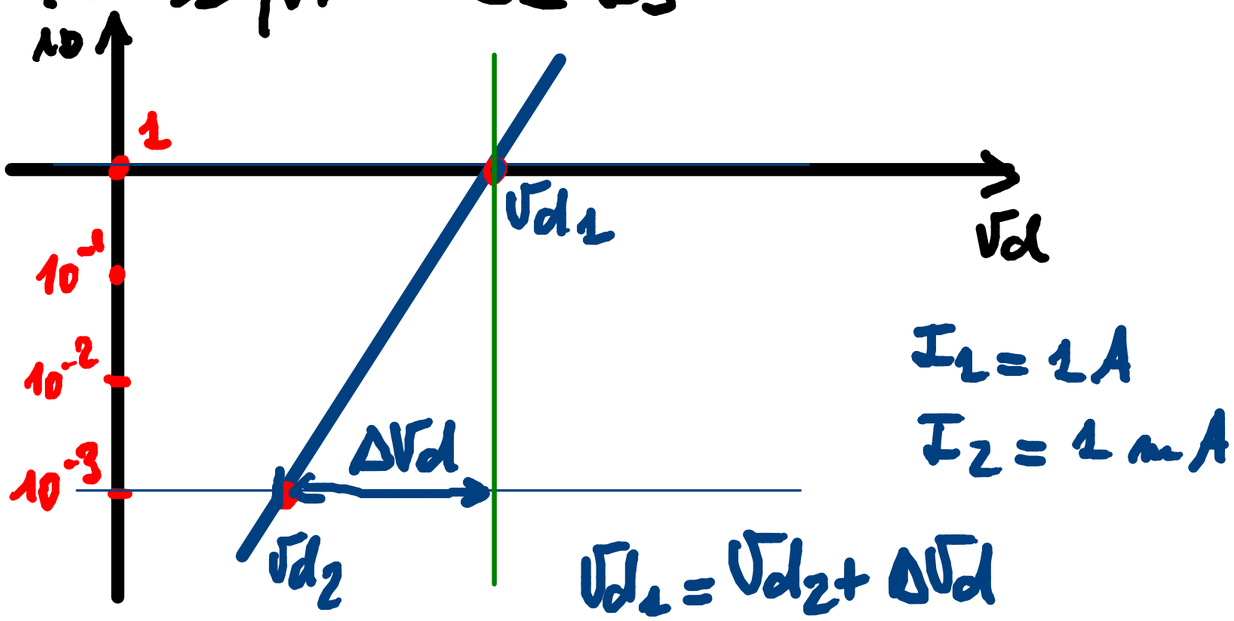


$i_2 = \dfrac{V_{Th}' - E_2}{R_{Th}' + R_2}$

$i_3 = i_1 - i_2$

$$i_D = I_S\left(e^{\frac{V_d}{\eta V_T}} - 1\right)$$

$V_d \gg \eta V_T \qquad i_D \simeq I_S e^{\frac{V_d}{\eta V_T}}$



$I_1 = 1\,A$

$I_2 = 1\,mA$

$V_{d1} = V_{d2} + \Delta V_d$

$$I_1 = I_S e^{\frac{V_{d1}}{\eta V_T}} = I_S e^{\frac{V_{d2}+\Delta V_d}{\eta V_T}}$$

$$I_2 = I_S e^{\frac{V_{d2}}{\eta V_T}}$$

$$\frac{I_1}{I_2} = \frac{10^3 I_2}{I_2} = \frac{I_S}{I_S}\frac{e^{\frac{V_{d2}}{\eta V_T}} \cdot e^{\frac{\Delta V_d}{\eta V_T}}}{e^{\frac{V_{d2}}{\eta V_T}}}$$

$$10^3 = e^{\frac{\Delta V_d}{\eta V_T}} \qquad \frac{\Delta V_d}{\eta V_T} = \ln 10^3 = 3\ln 10$$

$$\eta = \frac{\Delta V_d}{V_T \cdot 3 \cdot \ln 10}$$

$$i_d = I_S\left(e^{\frac{V_d}{n V_T}} - 1\right) \qquad V_T = \frac{k_B T}{q}$$

$I_S(T)$

$$\frac{dI_S(T)}{dT} = I_S(T) \cdot \frac{0{,}072}{K}$$

$$I_S(T) = I_S(T_0)\, e^{0{,}072(T - T_0)}$$

$$I_S(T_1) = 2 I_S(T_0) = I_S(T_0)\, e^{0{,}072(T_1 - T_0)}$$

$$T_1 = T_0 + \frac{\ln(2)}{0{,}072} = T_0 + 9{,}627\ K$$

V_γ

$$I_D = I_S\left(e^{\frac{V_\gamma}{\eta V_T}} - 1\right)$$

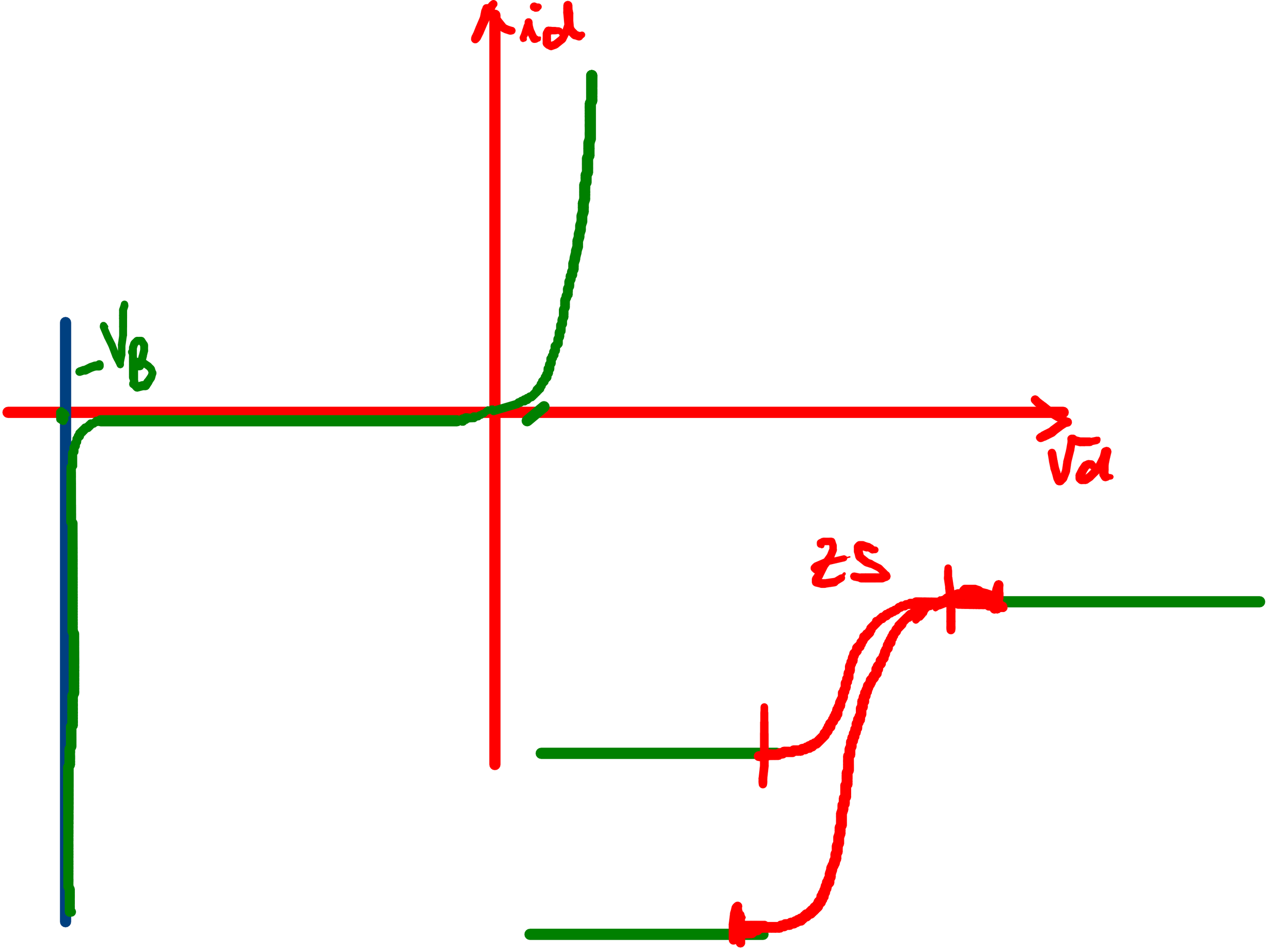
$$V_\gamma = \eta V_T \ln\left(\frac{I_D + I_S}{I_S}\right) \qquad V_T = \frac{k_B T}{q}$$

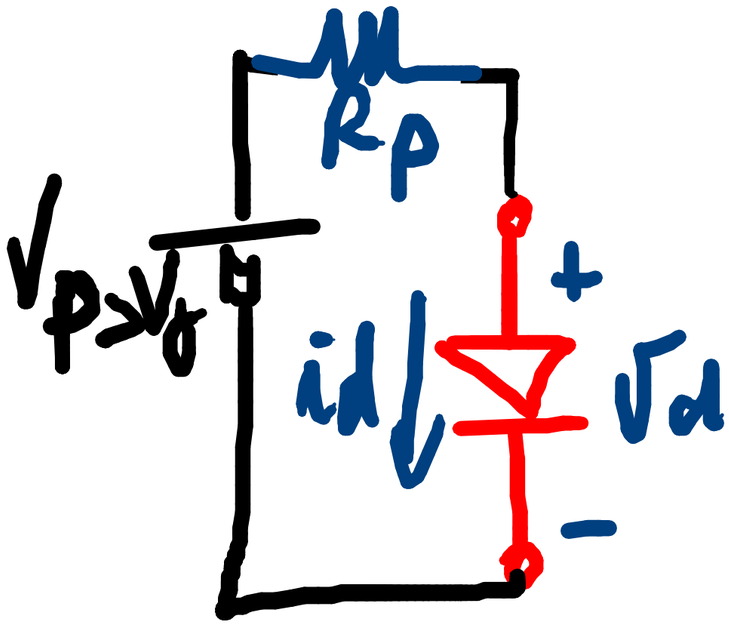
$$\frac{\delta V_\gamma}{\delta T} = \frac{V_\gamma}{T} + \eta V_T \frac{I_S}{I_D + I_S}\left(-\frac{I_D}{I_S^2}\right) I_S \cdot 0{,}072$$

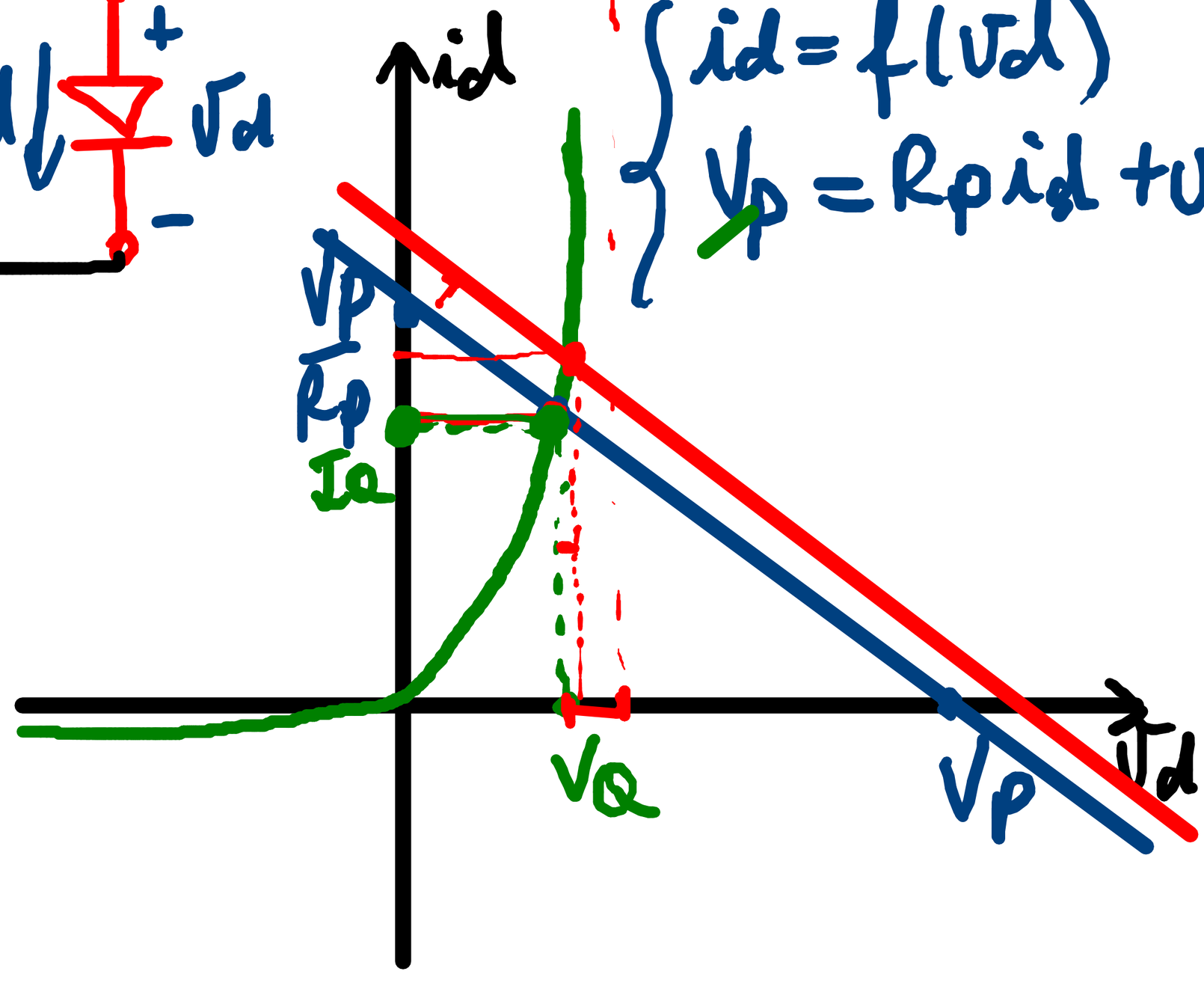
$$I_S \ll I_D$$

$$\frac{dV_\gamma}{\delta T} = \frac{V_\gamma}{T} - 0{,}072 \cdot \eta V_T$$

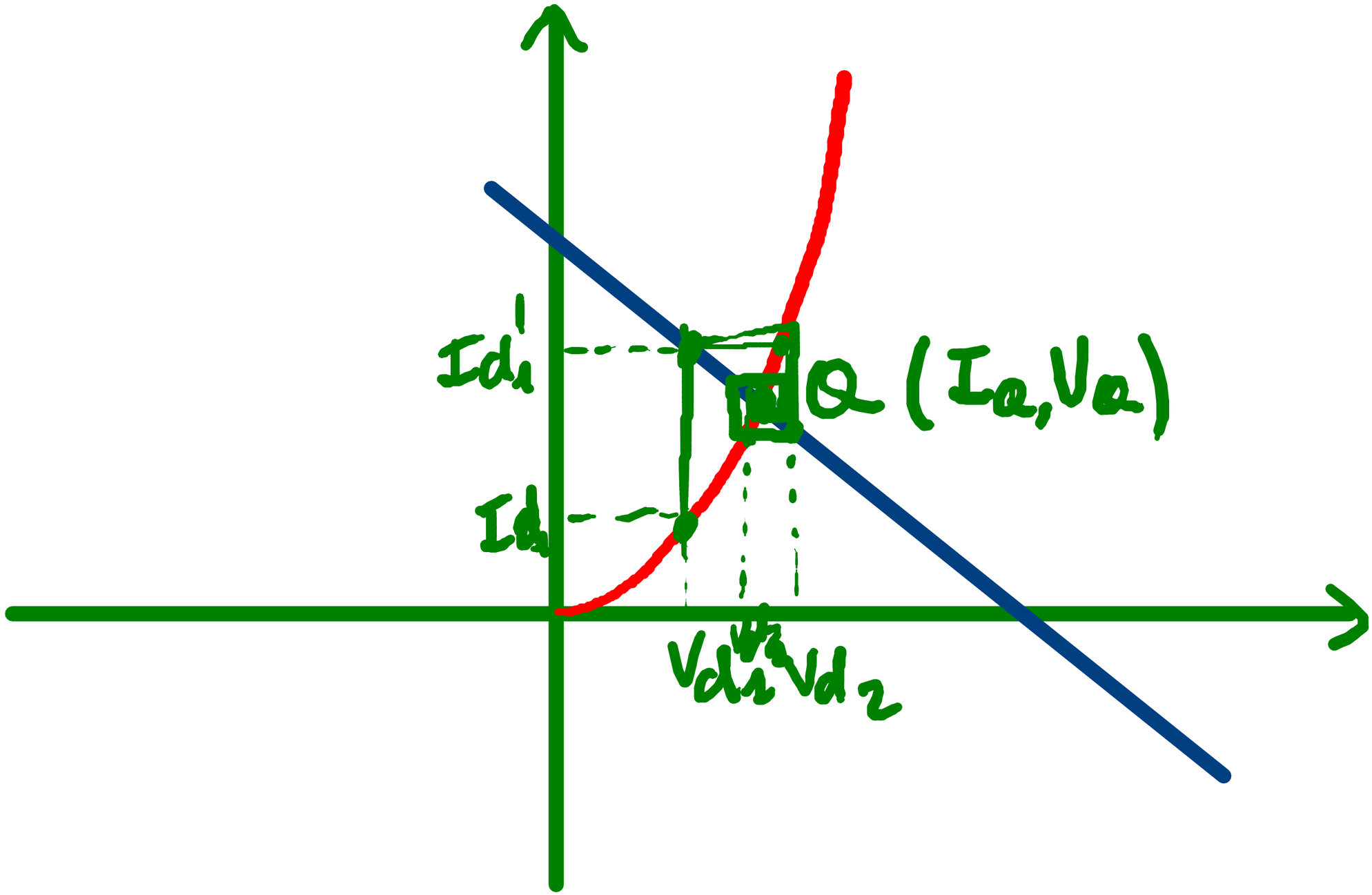
2mV 1°C


iD
-VB
VD
ZS





$$\begin{cases} id = f(Vd) \\ Vp = Rp\,id + Vd \end{cases}$$


Id1'
Id1
Q (IQ, VQ)
Vd1'
Vd2