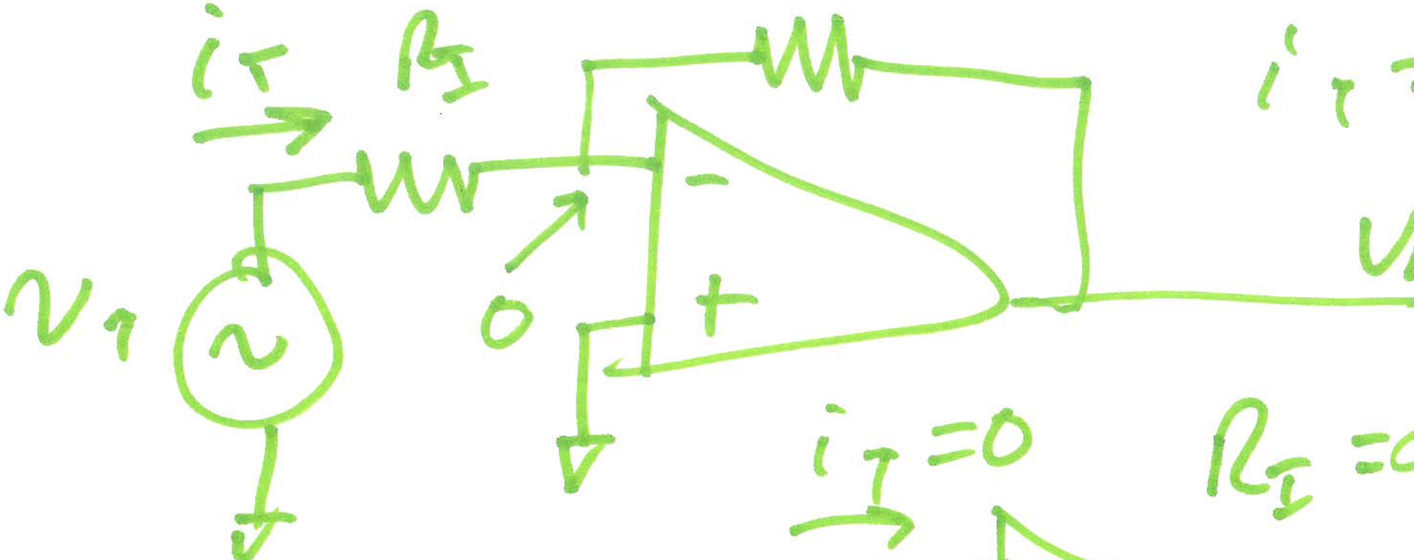
EE 320
Lecture 8

2/9/15

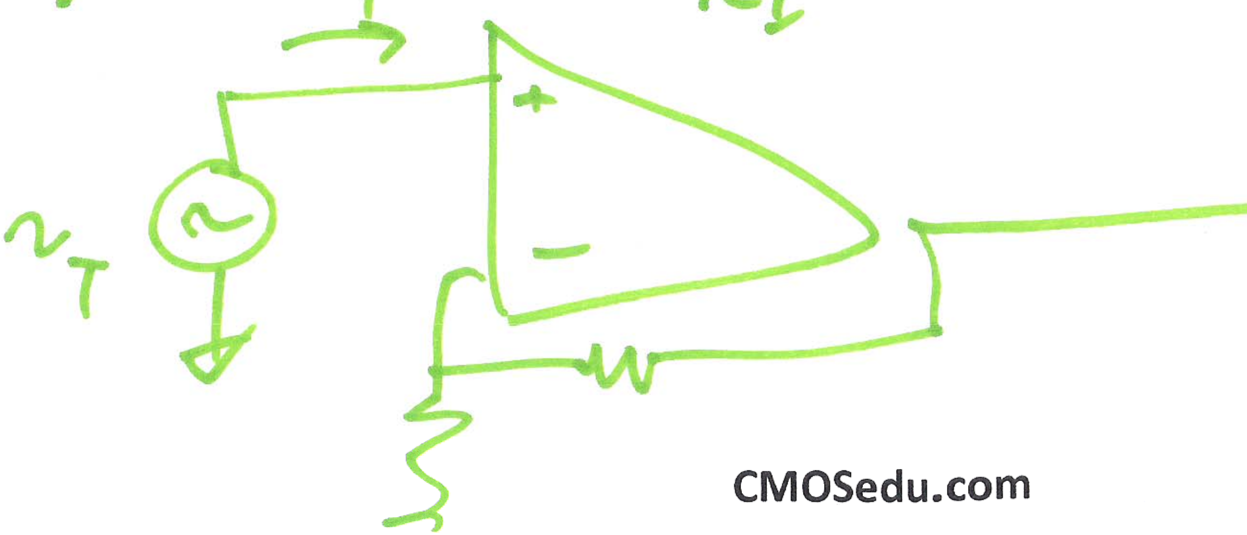
$$R_{IN} = \frac{v_I}{i_I} = R_I$$

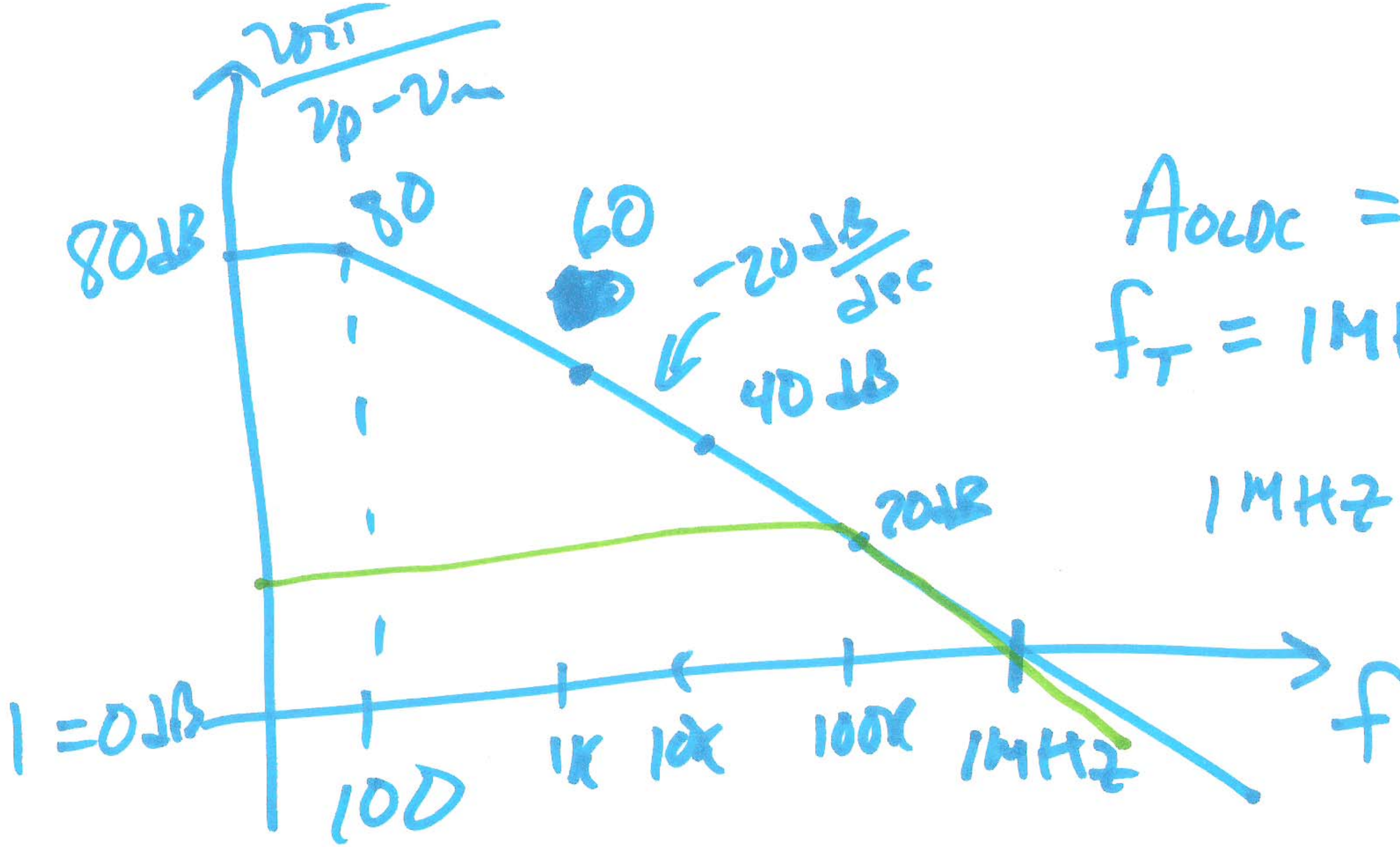


$$i_I = \frac{v_I - 0}{R_I}$$

$i_I = 0$

$R_I = \infty$





$A_{OLDC} = 80dB = 10K$

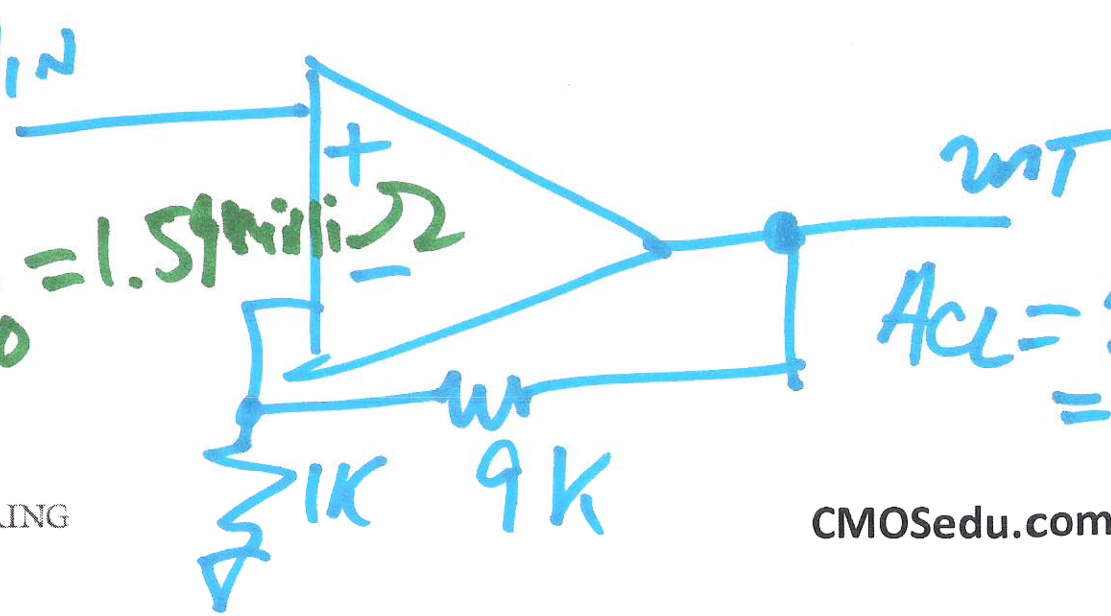
$f_T = 1MHz$

$1MHz = 10 \cdot f_{3dB,CL}$

$f_{3dB,CL} = 100kHz$

$\frac{1}{2\pi R} = 100$

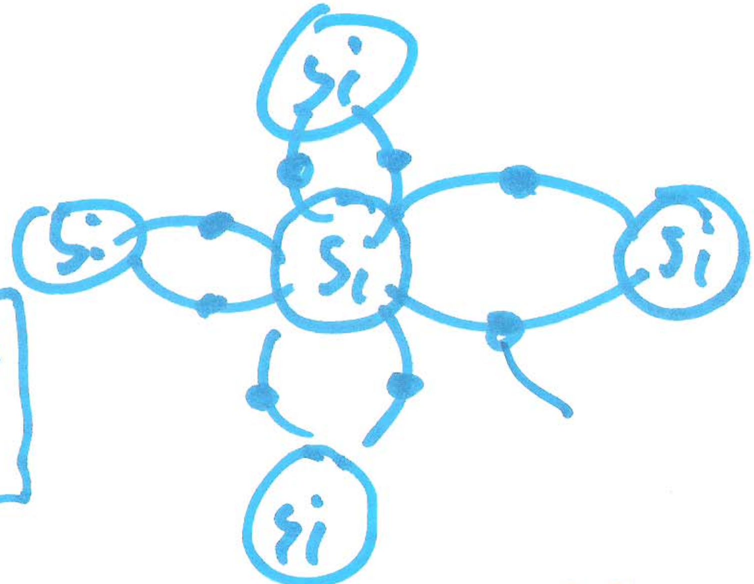
$R = \frac{1}{2\pi 100} = 1.59\,\text{milli}\,\Omega$

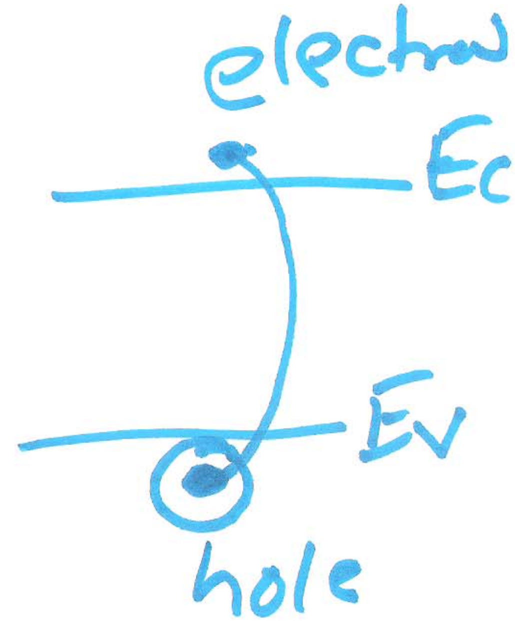


$A_{CL} = 20dB = 10$

Si — semiconductor

4 - Valence Electrons





$$N \cdot p = N_i^2$$

intrinsic Silicon

$N_i = N = p$

N ← # of electrons

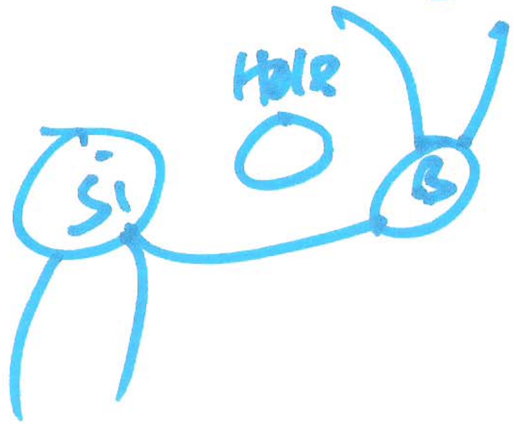
p ← # of holes $\frac{\text{carriers}}{cm^3}$

N_i ← intrinsic carrier generation due to heat

$14.5 \times 10^9 \frac{\text{carriers}}{cm^3}$

$N_A = \frac{\text{Atoms}}{\text{cm}^3}$ = Acceptor Atoms

Boron → 3 valence



density of Si ≈ $10^{22} \frac{\text{atoms}}{\text{cm}^3}$

$10^{16} \frac{\text{Atoms}}{\text{cm}^3}$

$p = N_A$ p-type

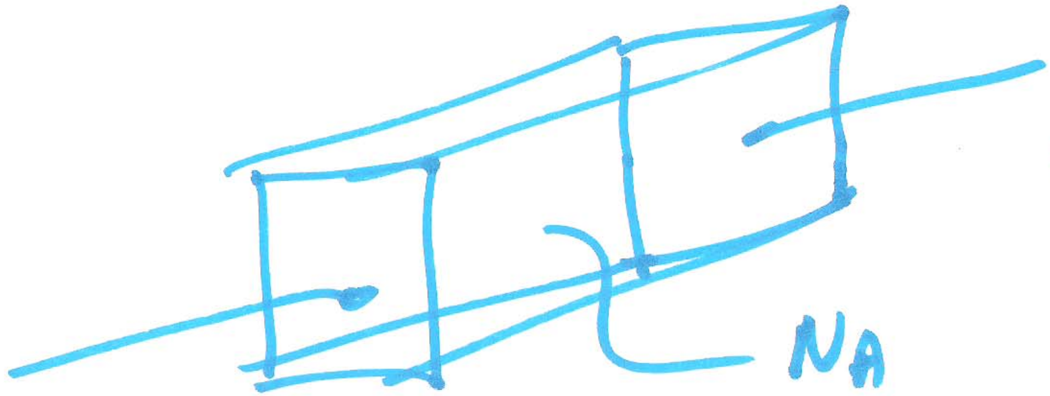
complete ionization

$n_i^2 = pn = N_A \cdot n$

$n = \frac{n_i^2}{N_A}$ $\frac{10^{22}}{10^{16}}$

$\swarrow$ 10^{6}

Dope Si: $N_A = 3 \cdot 10^{15}$ Atoms/cm^3



p-type

n-type

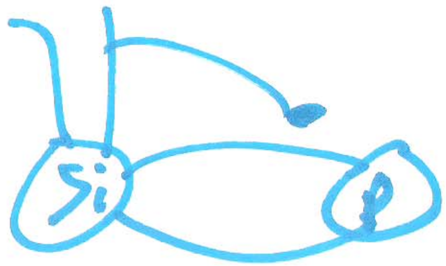
$p = \#$ of holes

$= N_A \ \frac{\text{holes}}{\text{cm}^3}$

$n = \frac{n_i^2}{p}, \ \frac{\text{electrons}}{\text{cm}^3}$

Donor Atoms, N_D, Phosphorous

→ 5 valence electrons



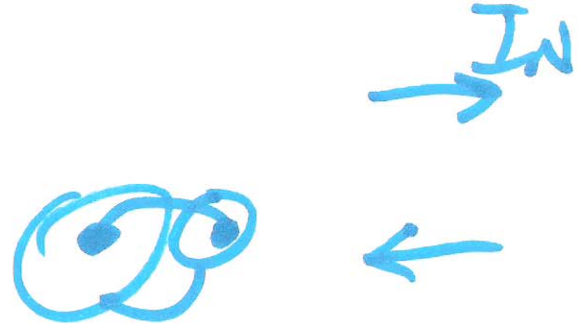
$N = N_D$

↑ # of electrons

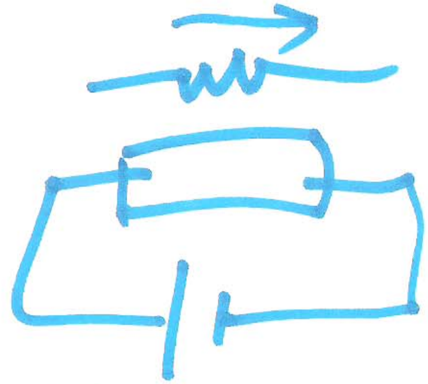
$$P = \frac{n_i^2}{N_D} = \frac{n_i^2}{N}$$

$$\mu_N = \frac{v_N\,(cm/s)}{\mathcal{E}\,(V/cm)} \rightarrow \frac{cm^2}{V \cdot s}$$

mobility



$I = I_N - I_P$



$$\mu_P \Rightarrow \frac{cm^2}{V \cdot s}$$

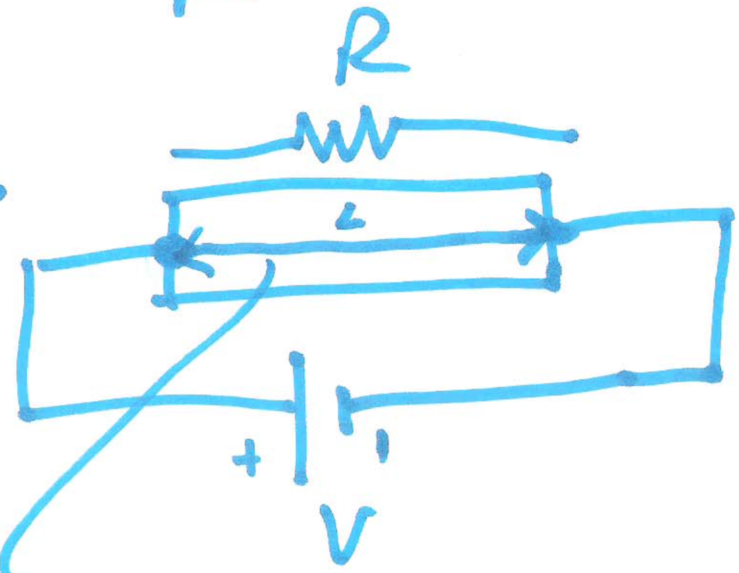
drift current → requires E field

diffusion current

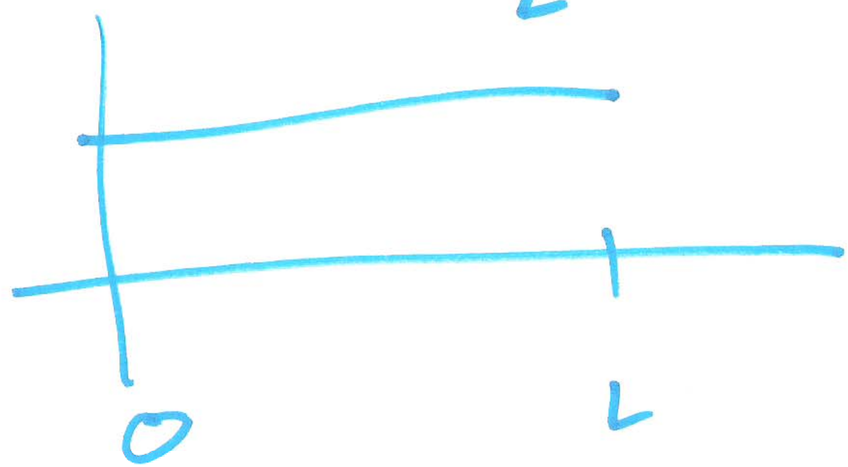
$$I = I_p + I_N = \frac{V}{R}$$

$$R = \frac{1}{\mu_N \cdot N \cdot q + \mu_p \cdot p \cdot q}$$

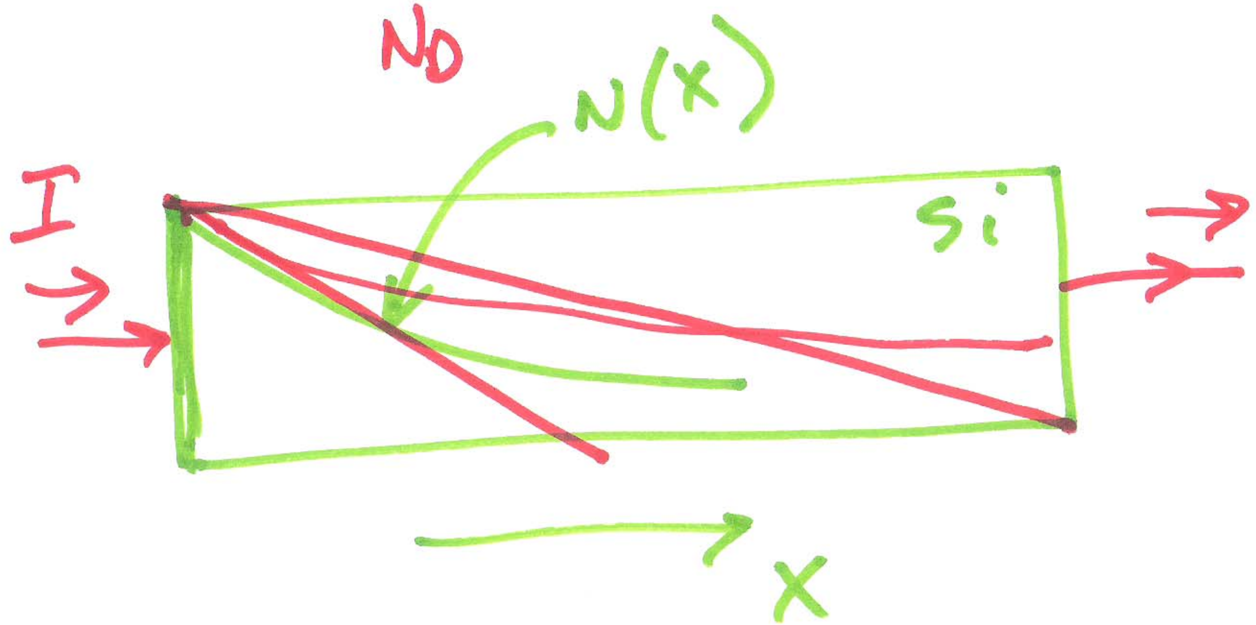
$\mu_N \rightarrow \frac{V}{\mathcal{E}}$



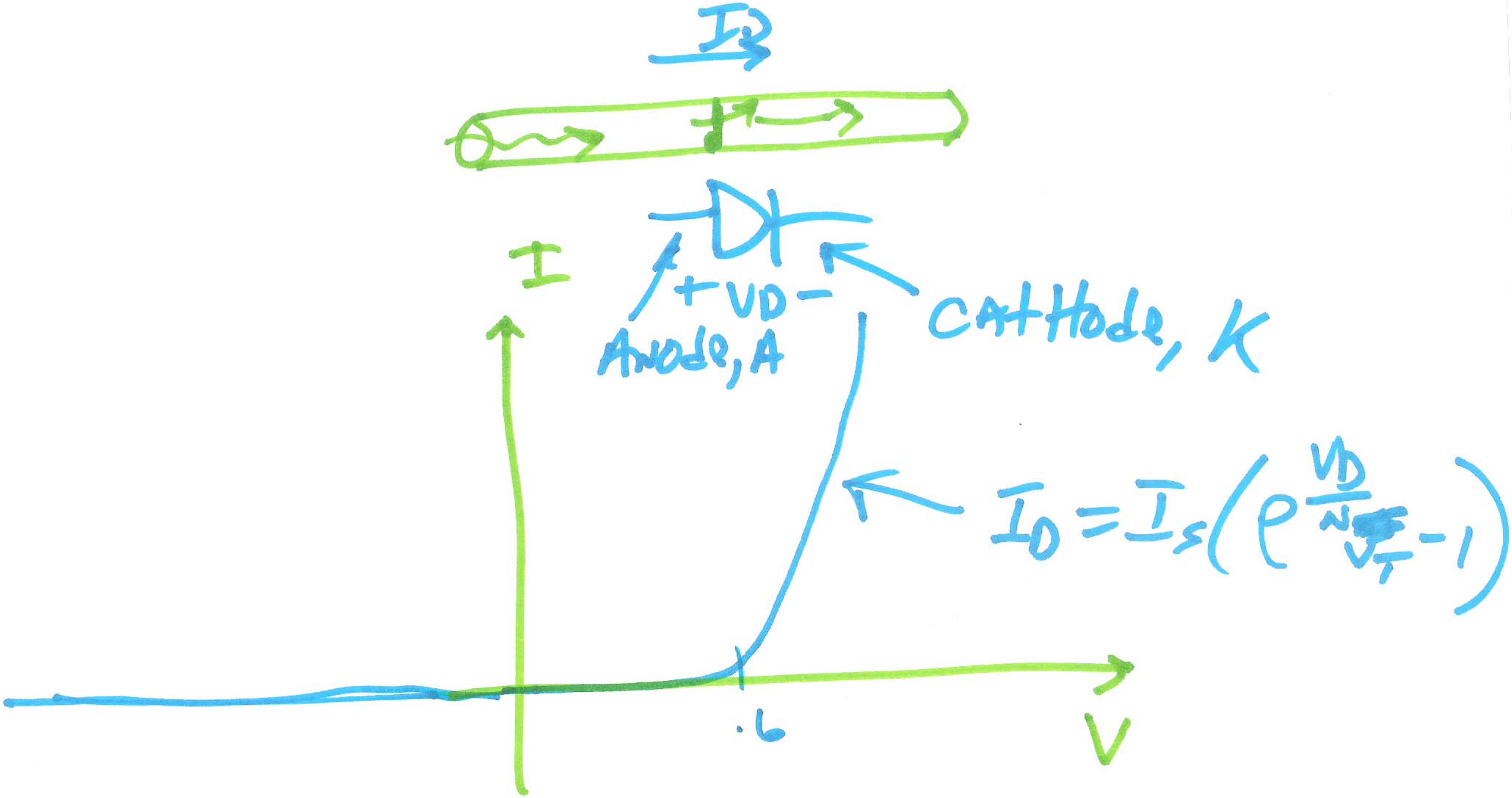
$$\mathcal{E} = \frac{V}{L}$$



diffusion current



$$J_N = q D_N \cdot \frac{dN(x)}{dx}$$



I_D
I
+ VD −
Anode, A
Cathode, K
I_D = I_S(e^(VD/NVT) − 1)
.6
V