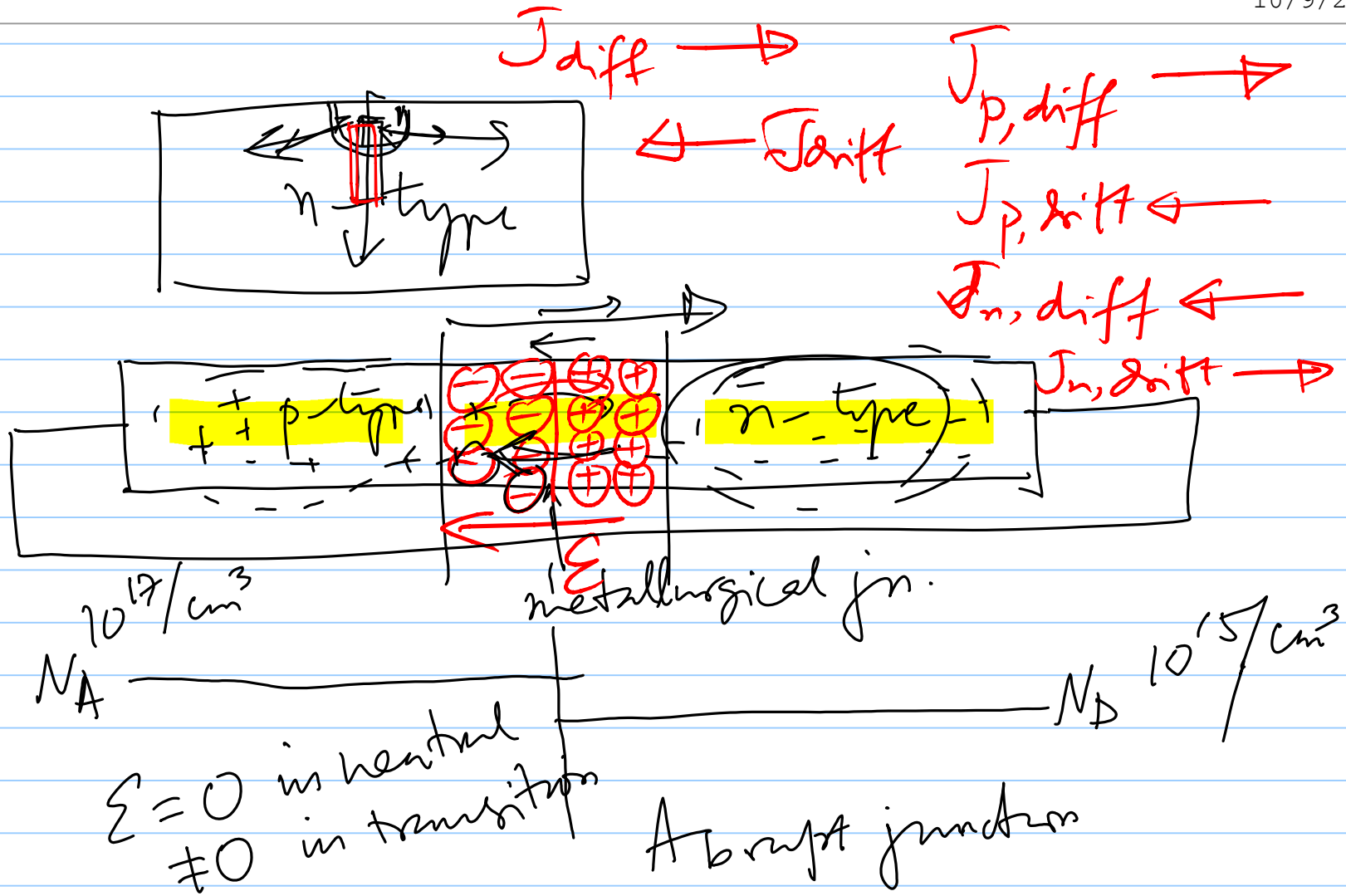
P-N junctions

10/9/2014



$$J_{drift} + J_{diff} = J = 0$$

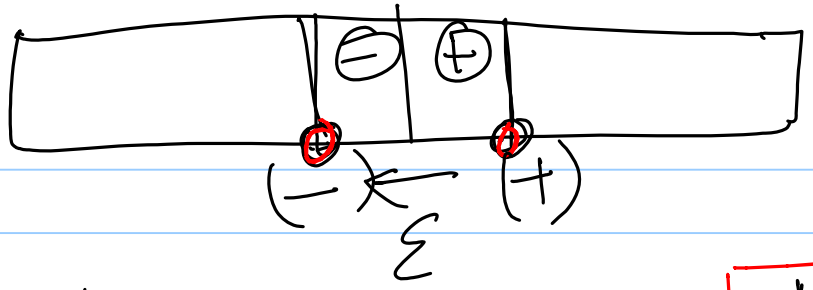
Detailed Balance

Thermal Eqb^m $\Rightarrow$ $J_{p,drift} + J_{p,diff} = J_p = 0$

$J_{n,drift} + J_{n,diff} = J_n = 0$

$$p q \mu_p \mathcal{E} - q D_p \frac{dp}{dx} = 0$$

$$\mathcal{E} = V_T \frac{d}{dx} \ln(p)$$



$p \rightarrow N_A = 10^{17}/cm^3$

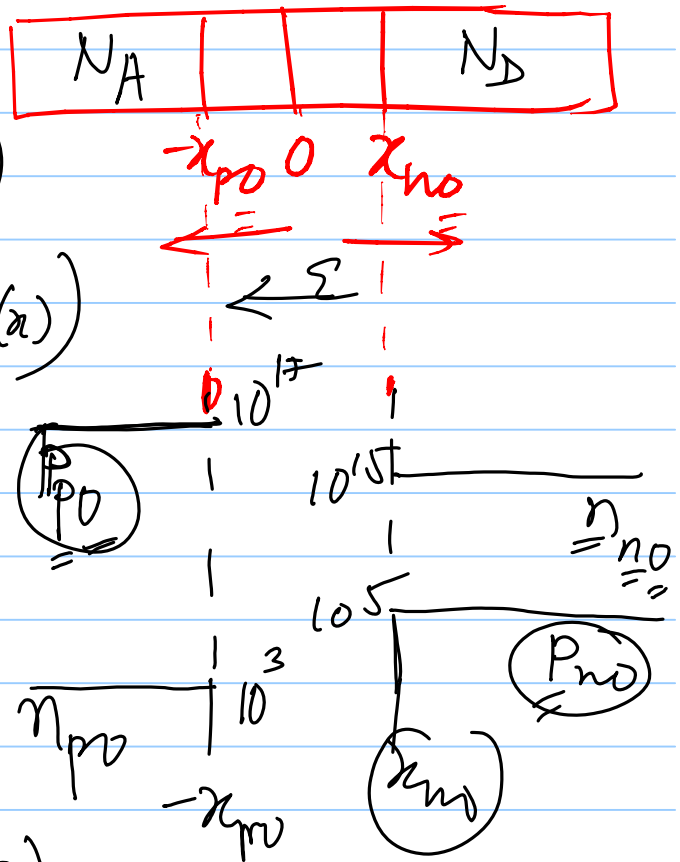
$n \rightarrow N_D = 10^{15}/cm^3$

$$\mathcal{E}(x) = V_T \frac{d}{dx} \ln(p)$$

$$-\int_{-x_{p0}}^{x_{n0}} \mathcal{E}(x)\,dx = -V_T \int_{\ln(p(-x_{p0}))}^{\ln(p(x_{n0}))} d\ln(p(x))$$

$$\left[V(x_{n0}) - V(-x_{p0})\right] = -V_T \ln\left(\frac{p_{n0}}{p_{p0}}\right)$$

$$V(x_{n0}) - V(-x_{p0}) = +V_T \ln\left(\frac{p_{p0}}{p_{n0}}\right)$$



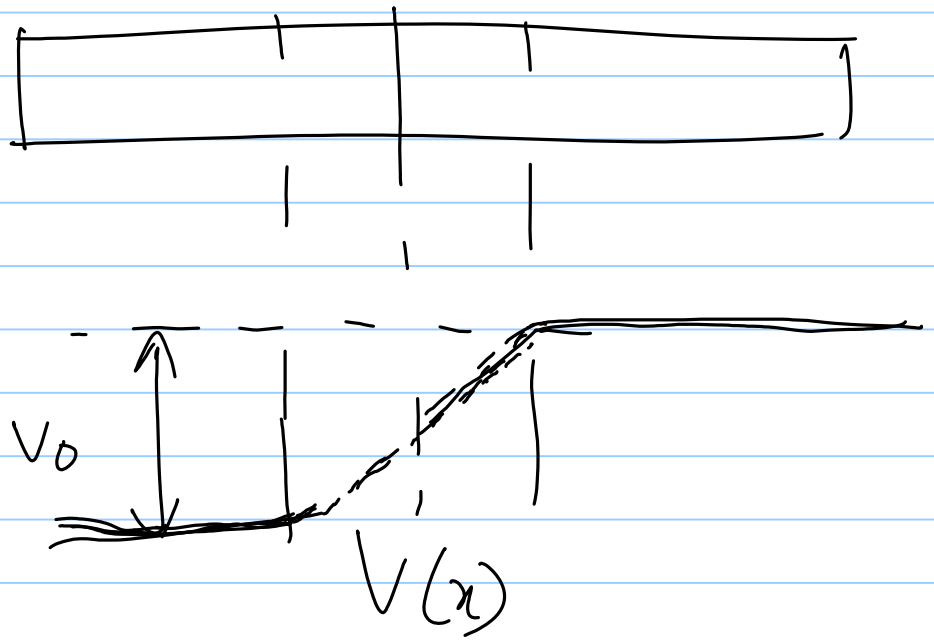
$$V_0 = V(x_{no}) - V(-x_{po}) = V_T \ln\left(\frac{p_{po}}{p_{no}}\right)$$

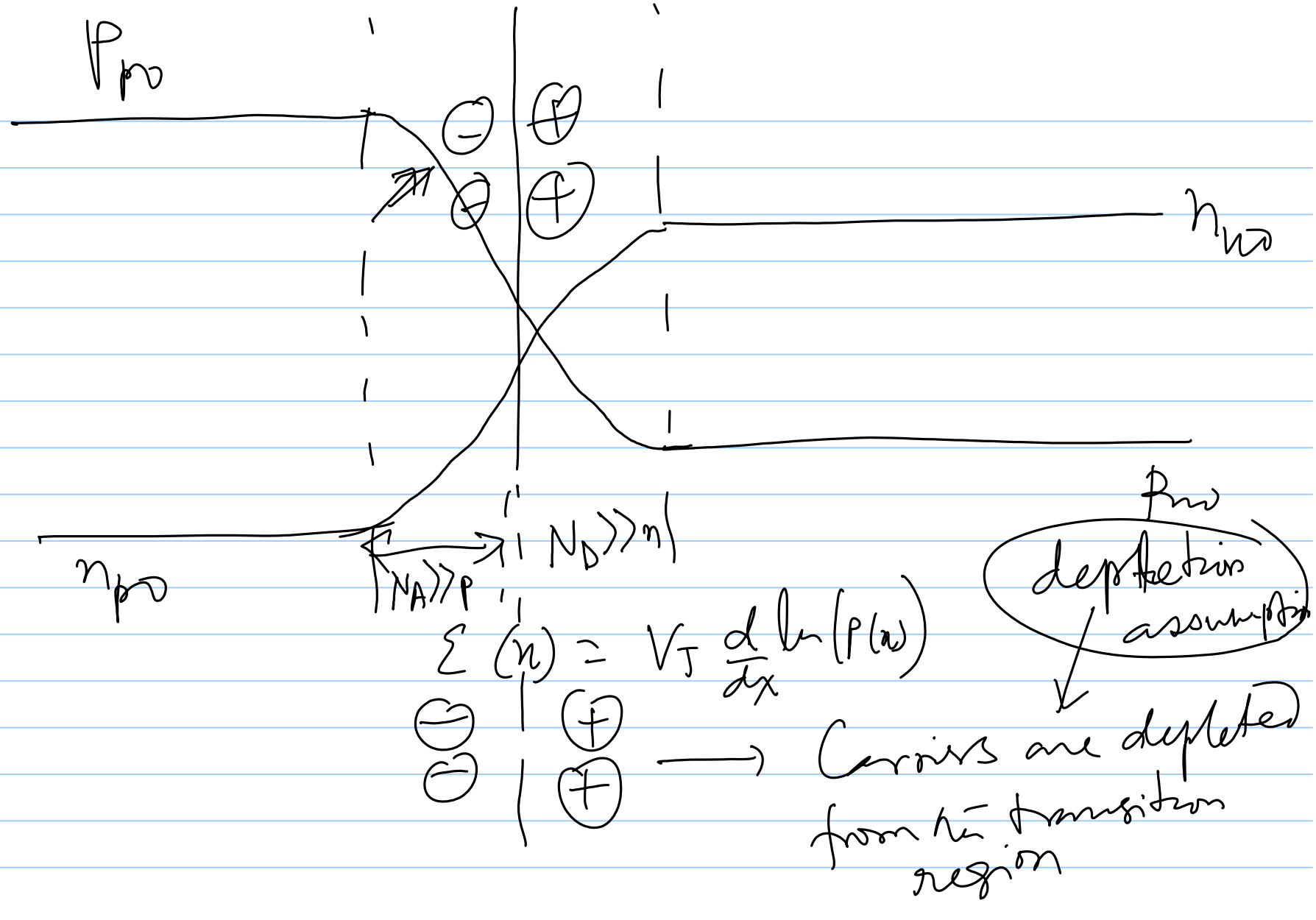
Contact potential

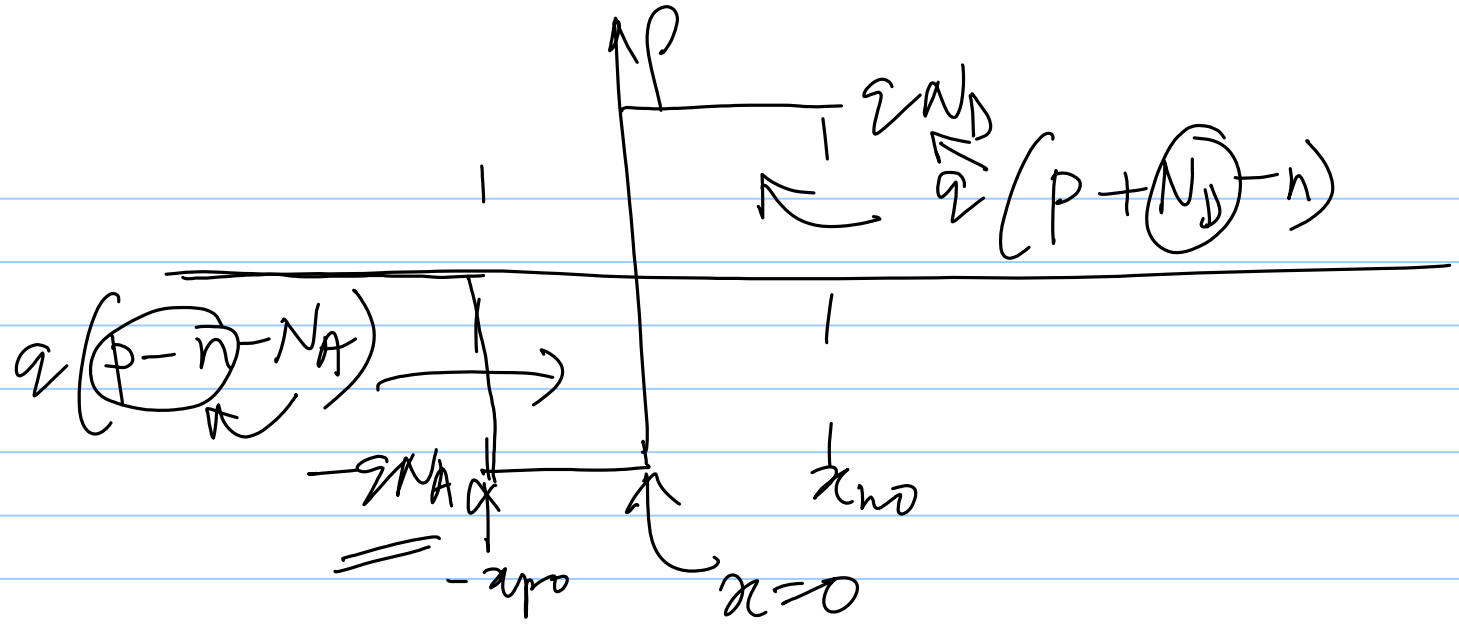
Built-in potential

Barrier potential under TE

$$V_0 = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$$




p_{p0}
n_{n0}
n_{p0}
$N_A \gg p$
$N_D \gg n$
$\mathcal{E}(x) \simeq V_T \frac{d}{dx} \ln(p(x))$
p_{n0}
depletion assumption
Carriers are depleted from the transition region



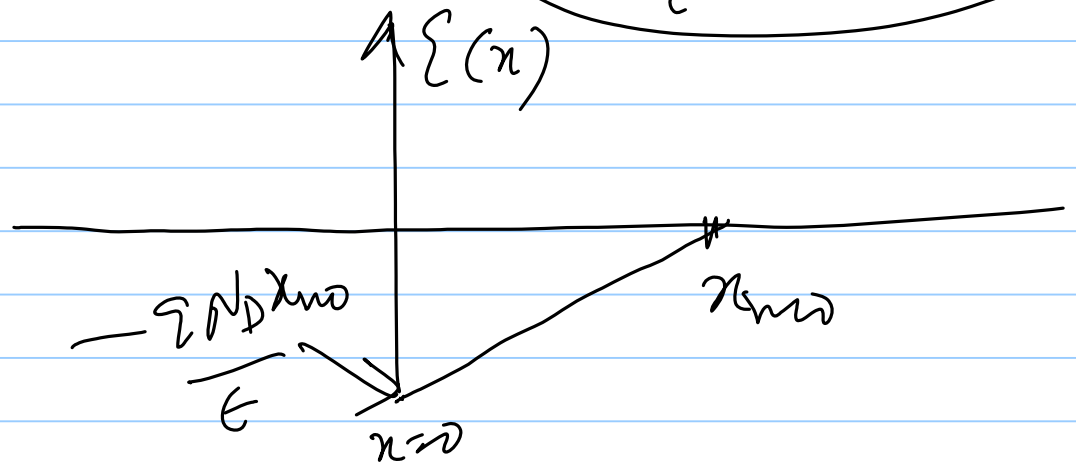
$$\frac{d\mathcal{E}}{dx} = \frac{qN_D}{\epsilon} \qquad 0 < x < x_{n0}$$

$$\frac{d\mathcal{E}}{dx} = -\frac{qN_A}{\epsilon} \qquad -x_{p0} < x < 0$$

$$\int_{\mathcal{E}(x)}^{\mathcal{E}(x_{no})} d\mathcal{E}(x) = \frac{qN_D}{\epsilon}\int_{x}^{x_{no}} dx$$

$$\mathcal{E}(x)\Big]_{x}^{x_{no}} = \frac{qN_D}{\epsilon}\cdot(x_{no}-x)$$

$$+\mathcal{E}(x) = -\frac{qN_D}{\epsilon}(x_{no}-x) \qquad 0<x<x_{no}$$



$$\frac{d\mathcal{E}}{dx} = -\frac{\rho N_A}{\epsilon} \qquad -x_{p0} < x < 0$$

$$\int_{-x_{p0}}^{x} d\mathcal{E} = -\frac{\rho N_A}{\epsilon} \int_{-x_{p0}}^{x} dx$$

$$\mathcal{E}(x) = -\frac{\rho N_A}{\epsilon}\left(x + x_{p0}\right)$$