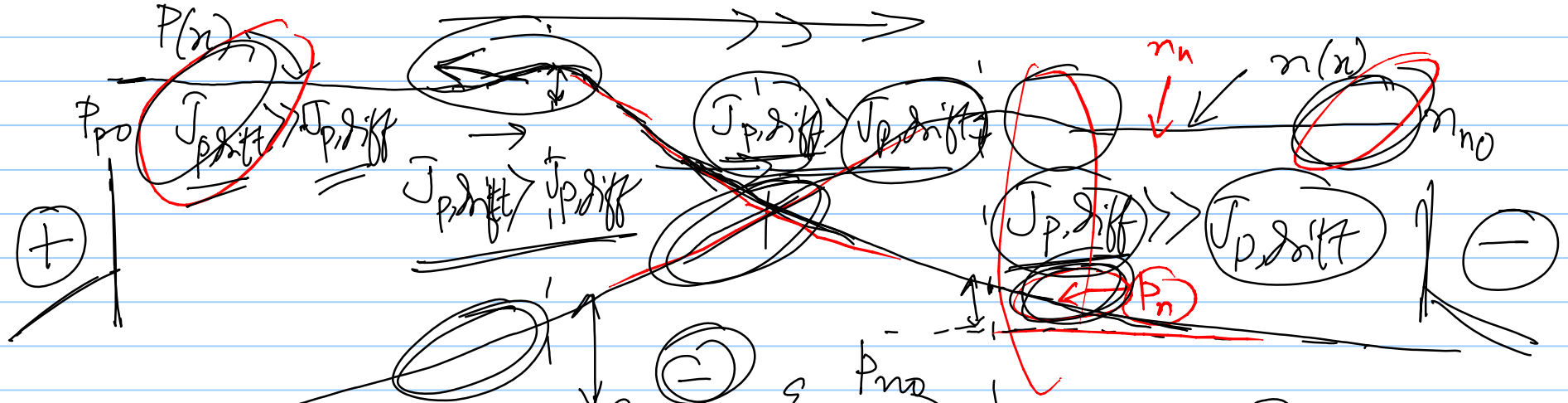
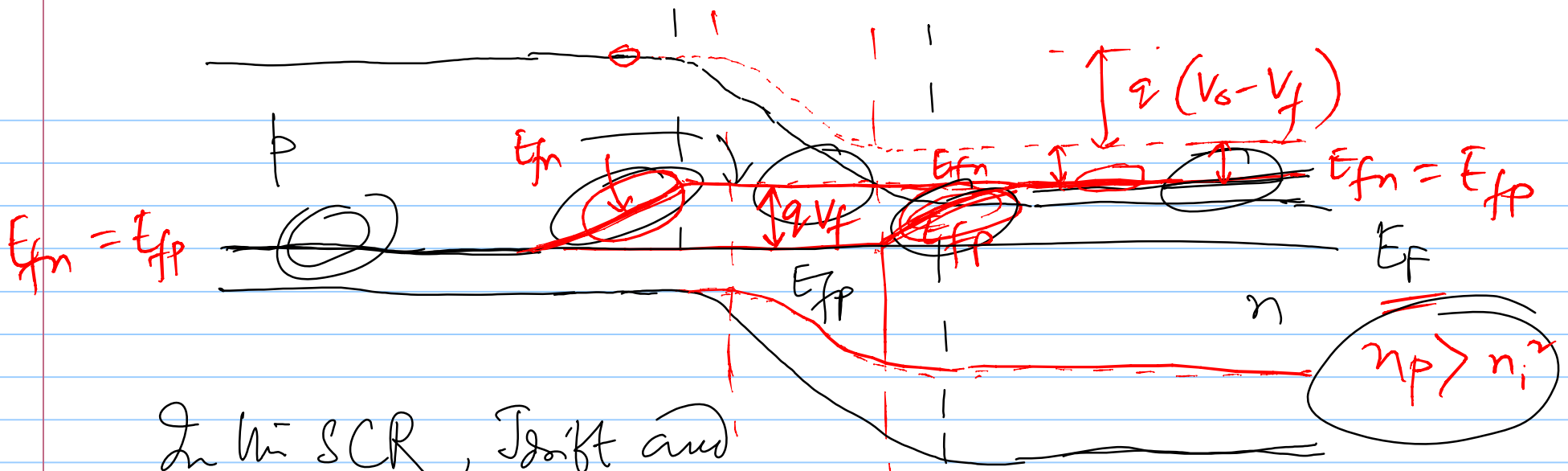
Current Transport in P-N. junction

16/9/2014





In the SCR, J_{drift} and J_{diff} are quite large and comparable

$J_{p,diff} \approx 1000$ unit
$J_{p,drift} \approx 999$ unit
$\Big\} J_p = 1$ unit

$$J_p = \sigma_p \frac{d}{dx}\left(E_{fp}/q\right)$$

$$J_n = \sigma_n \frac{d}{dx}\left(E_{fn}/q\right)$$

$$J = J_p + J_n = \sigma_p \frac{d(E_{fp}/q)}{dx} + \sigma_n \frac{d}{dx}(E_{fn}/q)$$

(1) — $\dfrac{\partial \delta p(x,t)}{\partial t} = -\dfrac{1}{q}\dfrac{\partial}{\partial x} J_p(x,t) - \dfrac{\delta p(x,t)}{\tau_p} = 0$

(2) — $\dfrac{\partial \delta n(x,t)}{\partial t} = \dfrac{1}{q}\dfrac{\partial}{\partial x} J_n(x,t) - \dfrac{\delta n(x,t)}{\tau_n} = 0$

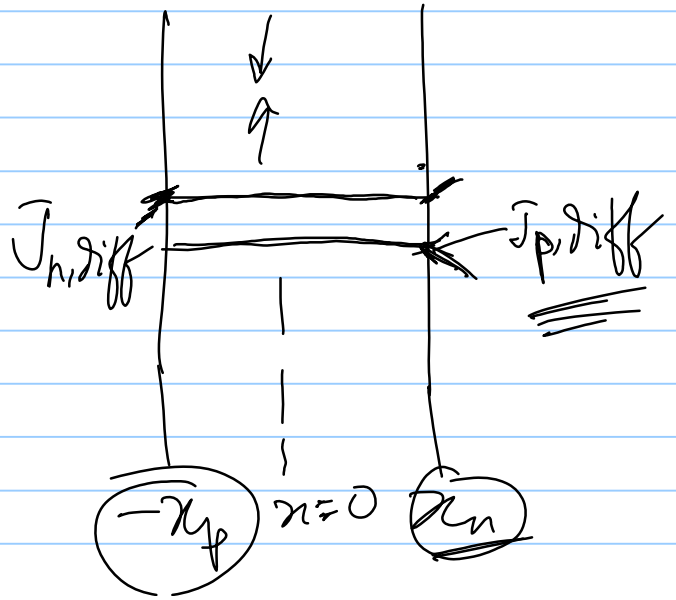
Under Steady State

(2) − (1)

$$\frac{1}{q}\frac{d}{dx}\left(J_h(x) + J_p(x)\right) = 0$$

$$J_h(x) + J_p(x) = \underline{\text{Constant}}$$

p

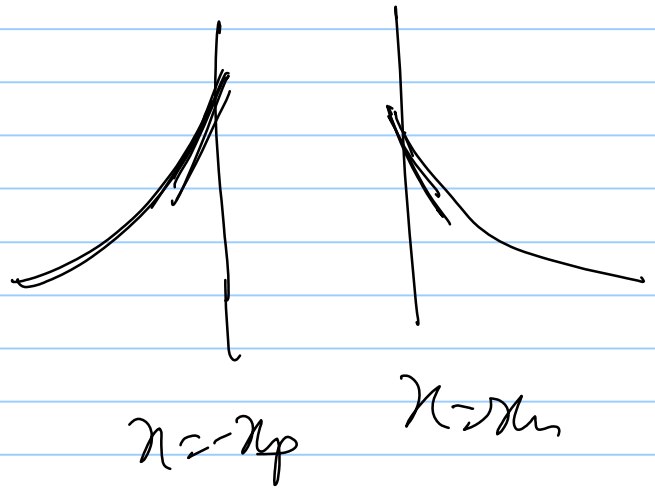


n

Assumption : No net carrier generation and recombination within SCR

↳ J_n is x-independent in SCR

↳ J_p " " " SCR

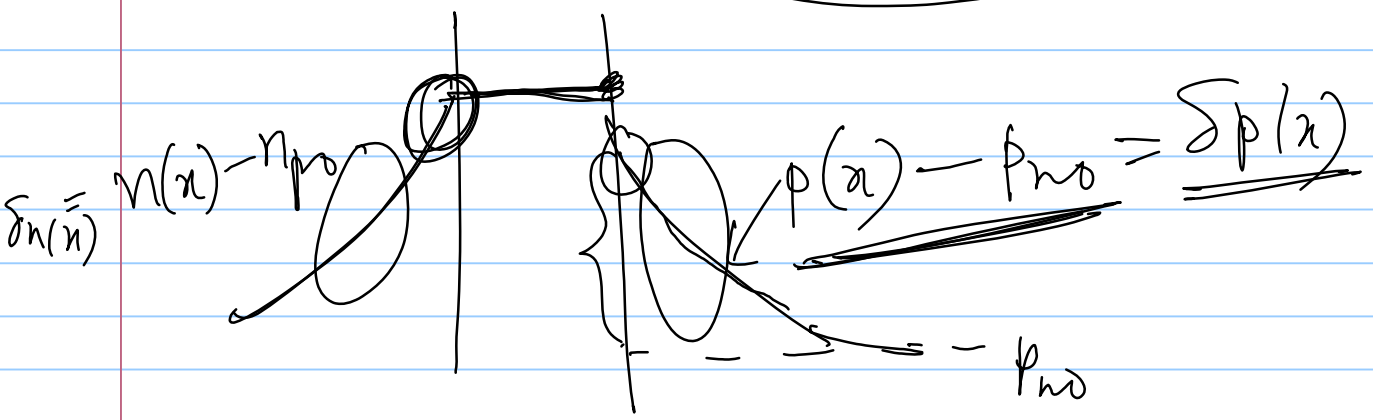


$$J = J_n(x=-x_p) + J_p(x=x_n)$$

$$= J_n(x=x_n) + J_p(x=-x_p)$$

$$J_{diff,p} = J_p(x=x_n) = -q D_p \frac{d(\delta p(x))}{dx}\Big|_{x=x_n}$$

$$J_{n,diff}(x=-x_p) = J_n(x=-x_p) = q D_n \frac{d}{dx}\delta n(x)\Big|_{x=-x_p}.$$



$$V_0 = V_T \ln\left(\frac{p_{p0}}{p_{n0}}\right) = V_T \ln\left(\frac{p(-x_{p0})}{p(x_{n0})}\right)$$

$$V_0 - V_f = V_T \ln\left(\frac{p_{p0} + \Delta p}{p_{n0} + \Delta p}\right)$$

$$V_0 - V_f = V_T \ln\left(\frac{p_p}{p_n}\right)$$

$$p_p \approx p_{p0}$$

$$p_{p0} = p_{n0}\, e^{V_0/V_T}$$

$$p_p = p_n\, e^{(V_0 - V_f)/V_T}$$

$$\frac{p_{n0}}{p_n} e^{V_f/V_T} = 1$$

$$p_n^{(a)} = p_{n0}\, e^{V_f/V_T}$$