Reading

Adel S. Sedra and Kenneth C. Smith, **Microelectronic Circuits** 7th Edition, *Oxford University Press*, 2014.

- Chapter 3.4-3.6

Review

$n_p = n_e$

Si Si Si
Si Si Si
Si Si Si
Si e⁻ Si Si
Si Si Si

$n_p \cdot n_e = n_i^2$

T ↓ 10K T ↗

$n_i = B T^{3/2} e^{-E_g/2kT}$ (E_g = 1.12 eV)

$n_i = n_e = n_p$

@ 300 K → $n_i = 1.5 \times 10^{10}$ carriers/cm³

4A 5A
Si → P

n-type semiconductor

Si Si Si
Si P⊕ Si e⁻
Si Si Si

$n_e = N_D$ $n_p \cdot n_e = n_i^2$

$n_p \cdot N_D = n_i^2$

$n_p = \frac{n_i^2}{N_D}$

4A 3A
Si → B

p-type semiconductor

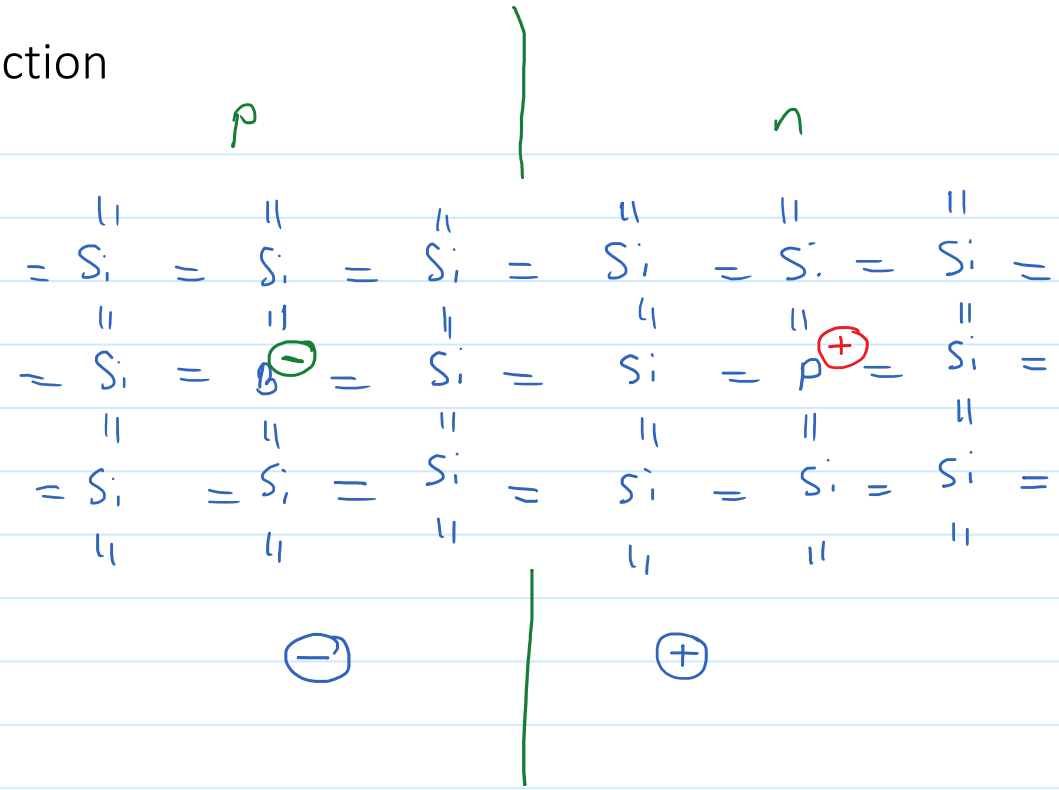
Si Si Si
Si B⊖ Si
Si Si Si

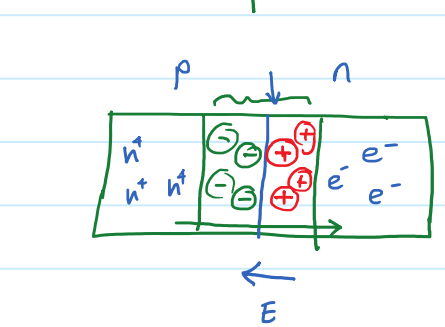
$n_p = N_A$ $n_e = ?$

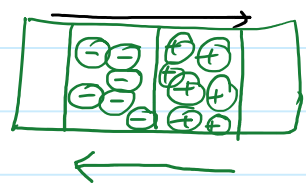
$n_i^2 = n_p n_e = N_A \cdot n_e$

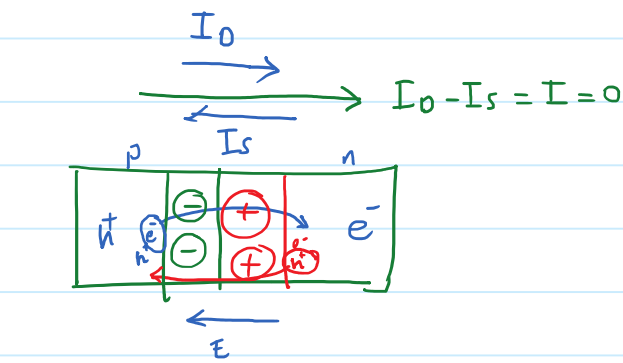
$n_e = \frac{n_i^2}{N_A}$

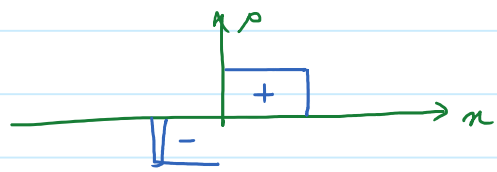
pn Junction

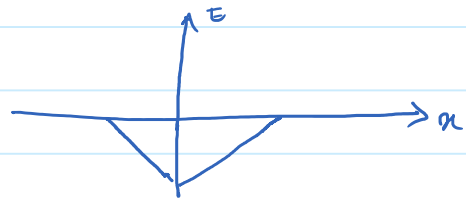

p
n
Si
B
P

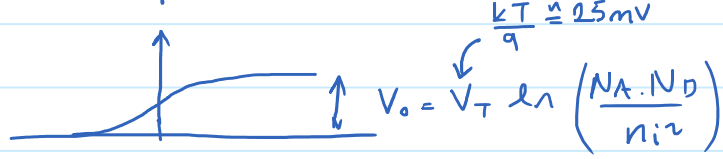

p
n
e⁻
E



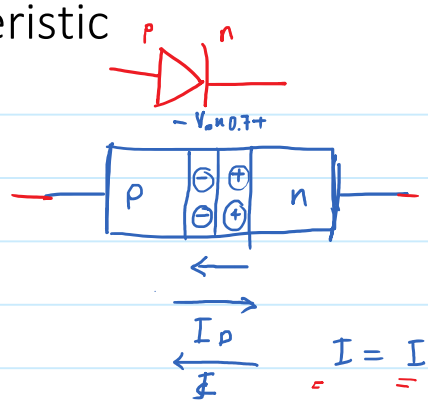

I_D
$I_D - I_S = I = 0$
I_S
p
n
E


p
n
+
-
$\frac{dE}{dx} = \nabla . E = \frac{\rho}{\varepsilon}$

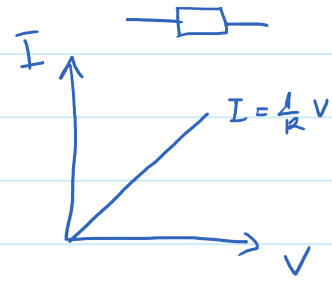

E
x
$E = -\nabla V$

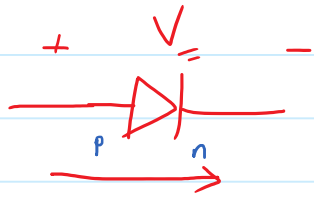

$\frac{kT}{q} \cong 25mV$
$V_o = V_T \ln\left(\frac{N_A . N_D}{n_i^2}\right)$

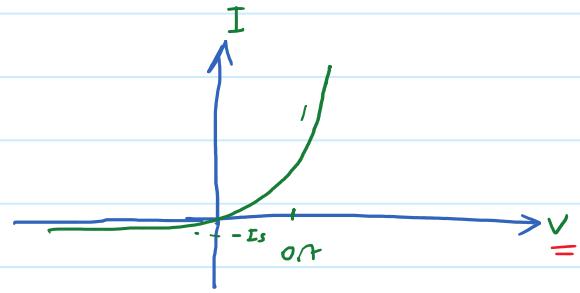
I-V Characteristic

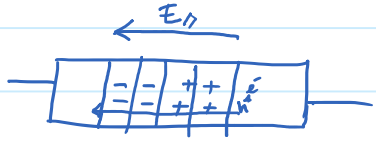


$I = I_D - I_S$









$$I = I_S \left(e^{V/V_T} - 1 \right)$$ ($V_T = 25mV$)

Reverse Breakdown