

# لجنة الهندسة الكهربائية / EE - Committee

مختص قوانين مادة (1) Electronics للشهر الأول

$$* E_g = E_c - E_v$$

$$* v_{drift/n} = -\mu_n \times E$$

$$v_{drift/p} = \mu_p \times E$$

$$J_{drift/n} = q n \mu_n E$$

$$J_{drift/p} = q p \mu_p E$$

$$J_{drift} = q(n\mu_n + p\mu_p) E = \sigma E \quad ; \quad \sigma = q(n\mu_n + p\mu_p)$$

$$J_{diffusion/n} = q D_n \frac{dn}{dx}$$

$$J_{diffusion/p} = q D_p \frac{dp}{dx}$$

$$* g_c(E) = \frac{m_n^* \sqrt{2m_n^*(E-E_c)}}{\pi^2 (\hbar)^3}$$

$$* g_v(E) = \frac{m_p^* \sqrt{2m_p^*(E_v-E)}}{\pi^2 (\hbar)^3}$$

Density of State

$$\hbar = \frac{h}{2\pi} \quad ; \quad h = (6.624)(10^{-34}) \text{ J.s}$$

$$* 0 \leq f(E) = \frac{1}{1 + e^{(E-E_f)/kT}} \leq 1 \quad [\text{Fermi Function}]$$

$$* n = N_c e^{(E_f - E_c)/kT} \quad ; \quad N_c = 2 \left( \frac{2\pi m_n^* kT}{h^2} \right)^{3/2}$$

$$p = N_v e^{(E_v - E_f)/kT} \quad ; \quad N_v = 2 \left( \frac{2\pi m_p^* kT}{h^2} \right)^{3/2}$$

$$* n = n_i e^{(E_f - E_i)/kT} \rightarrow n\text{-type}$$

$$p = n_i e^{(E_i - E_f)/kT} \rightarrow p\text{-type}$$

$$n \cdot p = n_i^2$$

$$k = (8.62)(10^{-5}) \text{ eV/K}$$

$$* p + N_D = n + N_A$$

$$* n = \frac{N_D}{2} + \sqrt{\left(\frac{N_D}{2}\right)^2 + n_i^2} \rightarrow n\text{-type}$$

$$p = \frac{N_A}{2} + \sqrt{\left(\frac{N_A}{2}\right)^2 + n_i^2} \rightarrow p\text{-type}$$

$$* \rho = \frac{1}{\sigma} = \frac{1}{q(n\mu_n + p\mu_p)} \quad (\text{Resistivity})$$

$$R = \rho \cdot \frac{L}{A} = \frac{1}{q(n\mu_n + p\mu_p)} \cdot \frac{L}{A}$$

جزء من كتاب  
بانت من قبة  
سماواتنا  
رطباً في الجنة

\*  $V = -\frac{1}{q} (E_c - E_{ref.})$

Electric Field  $\leftarrow E = -\frac{dV}{dx} = \frac{1}{q} \cdot \frac{dE_c}{dx} = \frac{1}{q} \cdot \frac{dE_v}{dx} = \frac{1}{q} \frac{dE_i}{dx}$

$\vec{j}_{drift/n} + \vec{j}_{diffusion/n} = 0$  (at equilibrium)

$\frac{D_n}{\mu_n} = \frac{RT}{q}$

$\frac{D_p}{\mu_p} = \frac{RT}{q}$

[ Einstein Relationship ]

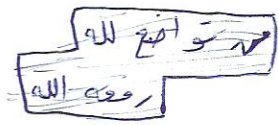
**PN-JUNCTION**

\*  $\rho$  (Density of charge) =  $\epsilon_0 \epsilon_r \frac{dE}{dx}$

$\rho = q(-n + p + N_D - N_A)$

$\rho(x) = \frac{\epsilon_0 \epsilon_r}{q} \frac{d^2 E_i}{dx^2}$

$\epsilon_0 = (8.854)(10^{-14}) \text{ F/cm}$   
 $\epsilon_r = (11.8) \text{ For Si}$



\*  $V_{bi}$  (Built-in Potential) =  $\frac{RT}{q} \ln\left(\frac{N_D N_A}{n_i^2}\right)$

\*  $\frac{dE}{dx} = \frac{1}{\epsilon_0 \epsilon_r} \rho(x)$

p-side  $\rightarrow E(x) = \frac{-q N_A}{\epsilon_0 \epsilon_r} (x + x_p)$

n-side  $\rightarrow E(x) = \frac{-q N_D}{\epsilon_0 \epsilon_r} (x_n - x)$

$\frac{x_p}{x_n} = \frac{N_D}{N_A}$

\*  $dV(x) = E(x) dx$

p-side  $\rightarrow V(x) = \frac{q N_A}{2 \epsilon_0 \epsilon_r} (x_p + x)^2$

n-side  $\rightarrow V(x) = V_{bi} - \frac{q N_D}{2 \epsilon_0 \epsilon_r} (x_n - x)^2$

\*  $x_n = \left( \frac{2 \epsilon_0 \epsilon_r}{q} \cdot V_{bi} \cdot \frac{N_A}{N_D(N_A + N_D)} \right)^{1/2}$

$x_p = \left( \frac{2 \epsilon_0 \epsilon_r}{q} \cdot V_{bi} \cdot \frac{N_D}{N_A(N_A + N_D)} \right)^{1/2}$

$W = x_n + x_p$

$= \left[ \frac{2 \epsilon_0 \epsilon_r}{q} \cdot V_{bi} \cdot \left( \frac{1}{N_A} + \frac{1}{N_D} \right) \right]^{1/2}$

وفقاً للمعادلة إلى  
 الخيط و المبدأ

\* عند التماس  
 \* عند سطح