ECE 235: Introduction to Solid State Electronics

Discussion

Week 10

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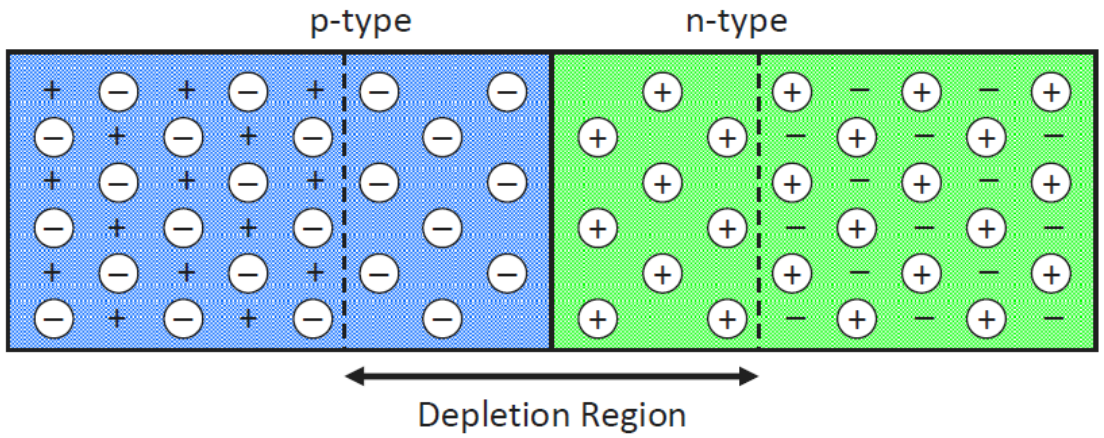
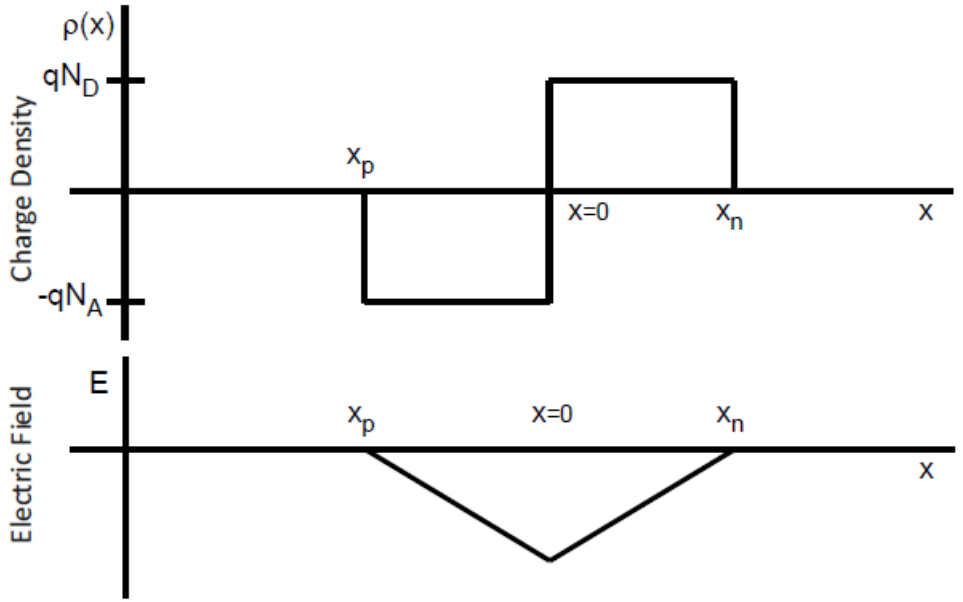
PN Junction





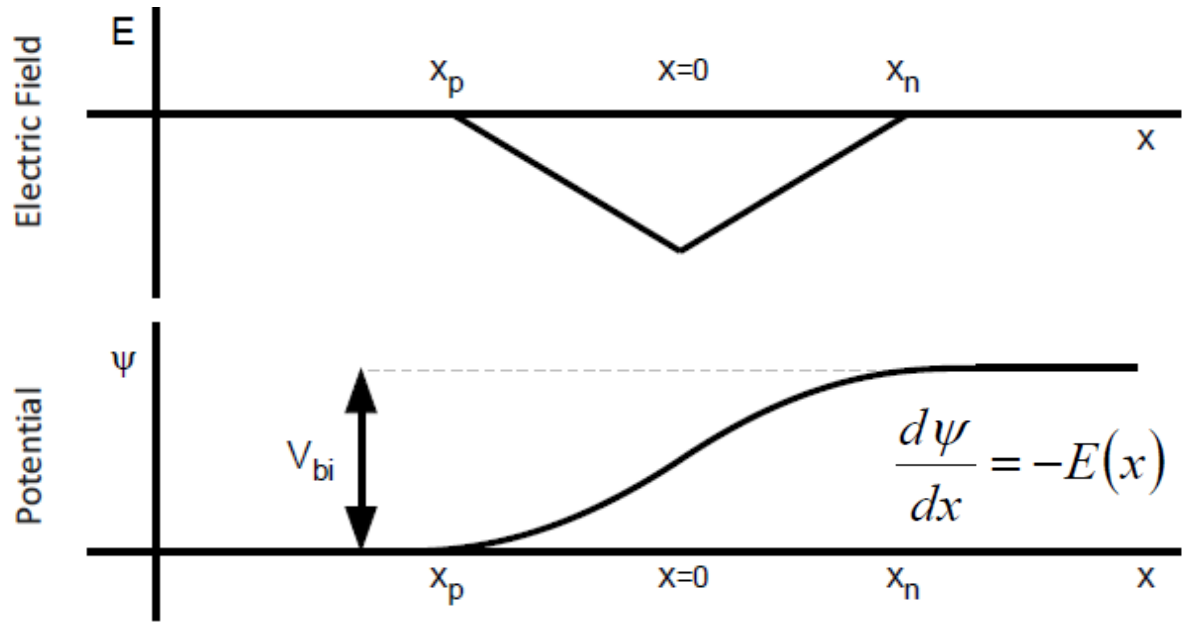
$$\frac{dE}{dx} = \frac{\rho(x)}{\varepsilon}$$

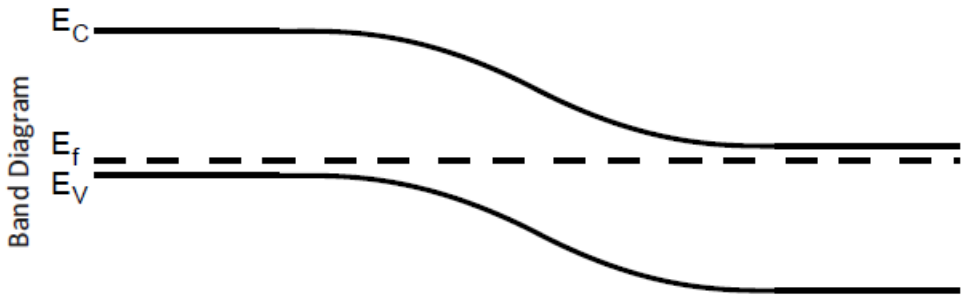
ε is the permittivity of Silicon

$$E_{\max} = -\frac{qN_A}{\varepsilon} x_p = -\frac{qN_D}{\varepsilon} x_n$$

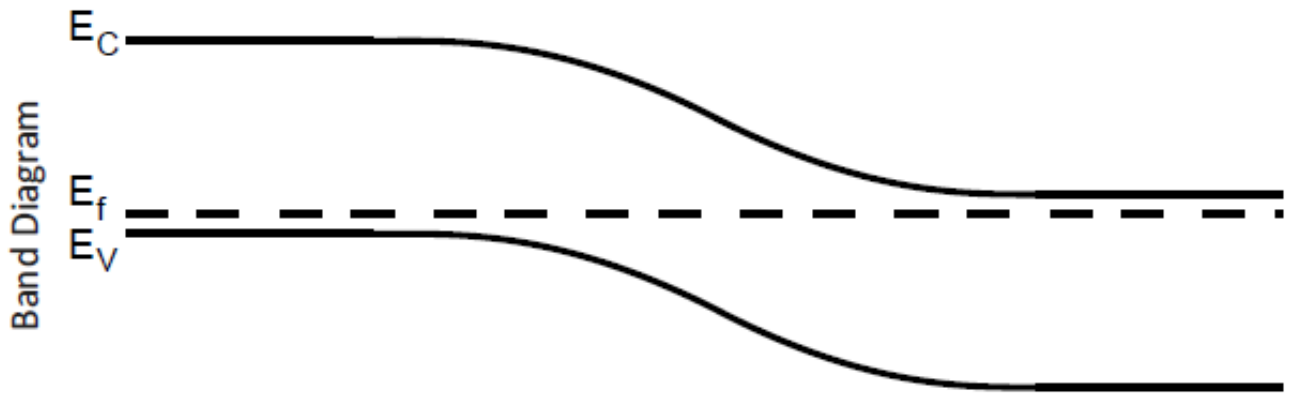
$$N_a x_p = N_d x_n$$

Potential Profile



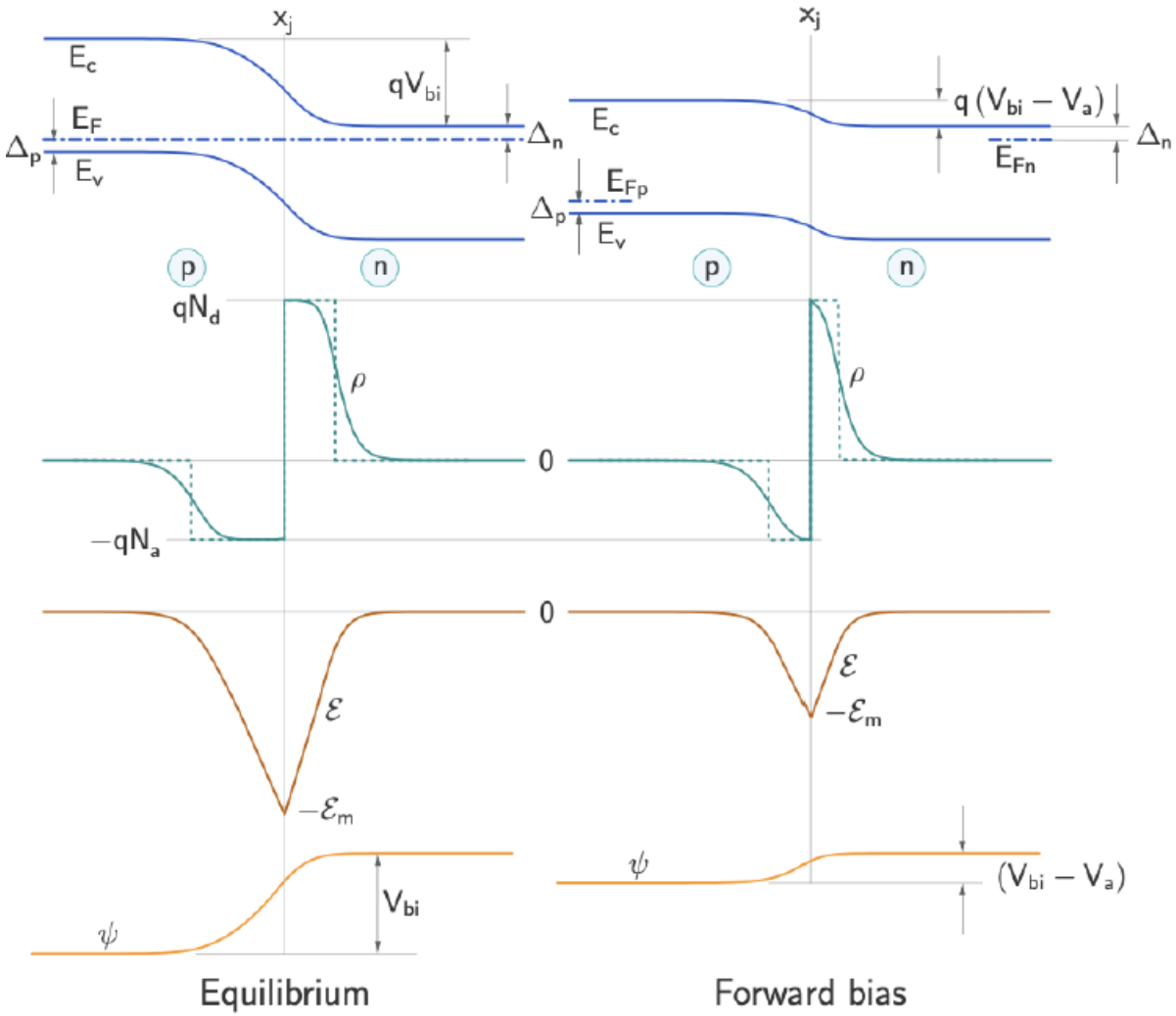


Built-in Potential

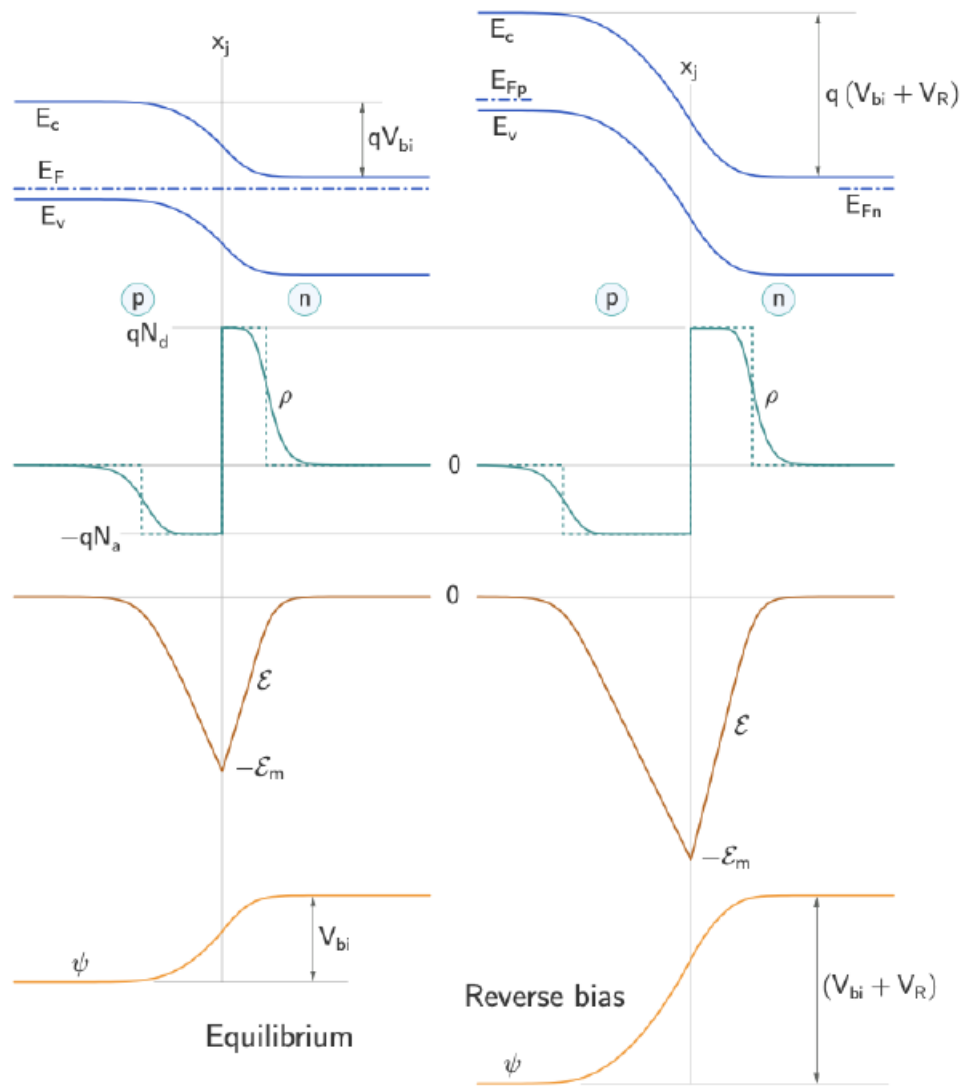


$$V_{bi} = \frac{kT}{q} \ln\left(\frac{N_A N_D}{n_i^{\,2}} \right)$$

Forward bias



Reverse bias



Practice Problem 1

Consider a silicon pn junction diode at 300 K with doping concentrations of $N_d = 10^{15} cm^{-3}$ and $N_a = 2 \times 10^{17} cm^{-3}$. Given that $n_i = 1.5 \times 10^{10} cm^{-3}$, find the built-in potential.

Practice Problem 2

A silicon pn junction diode has a depletion width of $x_n = 0.8644\ \mu m$ in the n side. Calculate the maximum electric field in the diode at zero bias. Silicon dielectric constant of 11.7 and given that $N_d = 10^{15} cm^{-3}$.

Practice Problem 3

A silicon pn junction diode has a built in potential of 0.7 V at 300 K. If both the n and p side of the diode has the same doping concentration, find the doping density. Given that $n_i = 1.5 \times 10^{10} cm^{-3}$.

Practice Problem 4

For a pn junction diode $N_d = 10^{15} cm^{-3}$ and $N_a = 10^{16} cm^{-3}$. If the depletion width in the n side is $0.8644\ \mu m$, find the total depletion width.