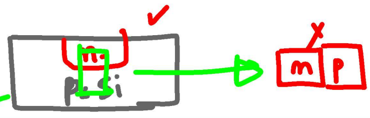
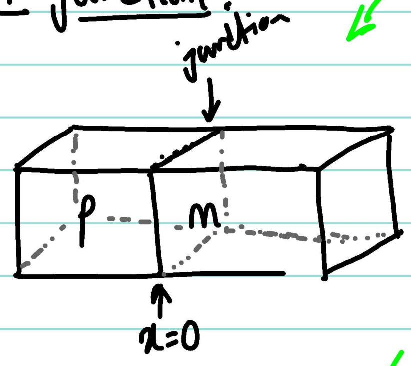
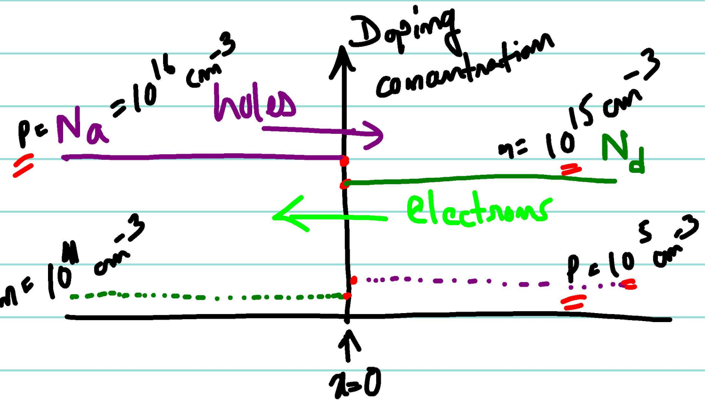
Lec-4



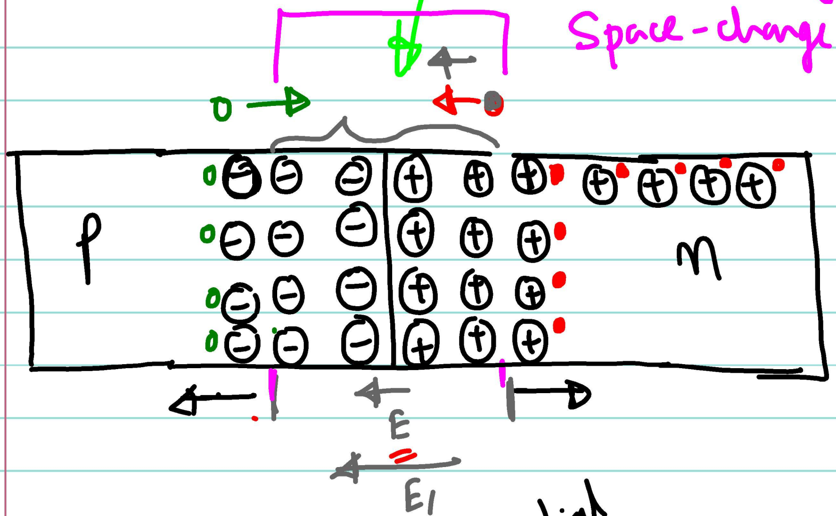
pn junction:





Depletion region

Space-charge region

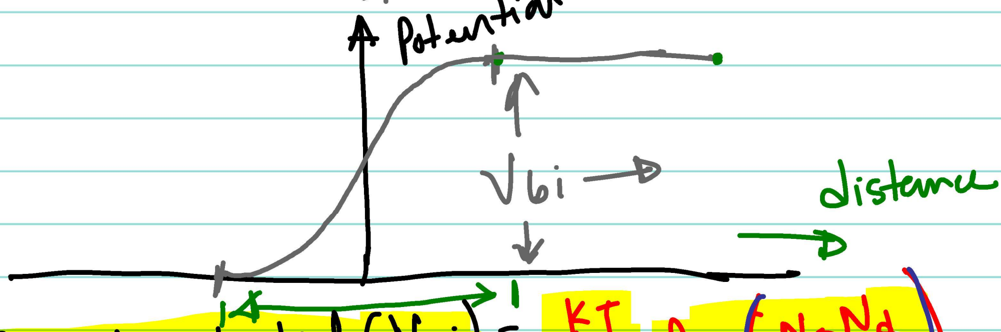


⊕ Ionized Donors

⊖ Ionized Acceptors

• electrons

o holes

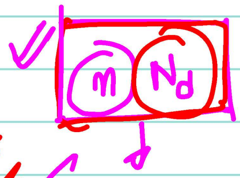


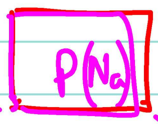
$$\text{Built-in potential } (V_{bi}) = \frac{KT}{q} \ln\left(\frac{N_a N_d}{n_i^2}\right)$$

$$= V_T \ln\left(\frac{N_a N_d}{n_i^2}\right)$$

V_T → 0.026 V at 300K

Doubt





$n_o p_o = n_i^2$

$N_d p_o = n_i^2$

$n_o N_a = n_i^2$

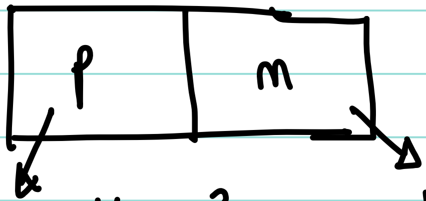
$n_o = \frac{n_i^2}{N_a}$

$\cancel{N_a N_d = n_i^2}$

Built-in potential:

Si → $n_i = 1.5 \times 10^{10}\ cm^{-3}$ at $T = 300K$

$V_T = 26\ mV.$



Case I

$N_a = 10^{16}\ cm^{-3}$ $N_d = 10^{15}\ cm^{-3}$

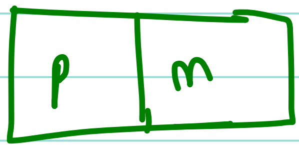
$$V_{bi} = V_T \ln\left(\frac{N_a N_d}{n_i^2}\right) = 0.637\ V.$$

Case II

$N_a = 10^{17}\ cm^{-3}$ $N_d = 10^{16}\ cm^{-3}$

$V_{bi} = 0.757\ V.$

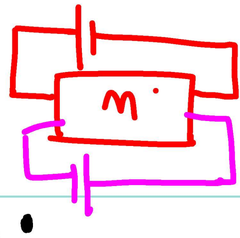
GaAs → "Eg" higher



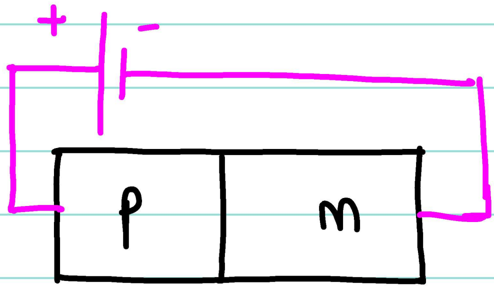
$N_a = 10^{16}\ cm^{-3}$ $N_d = 10^{15}\ cm^{-3}$

$$V_{bi} = V_T \ln\left(\frac{N_a N_d}{n_i^2}\right)$$

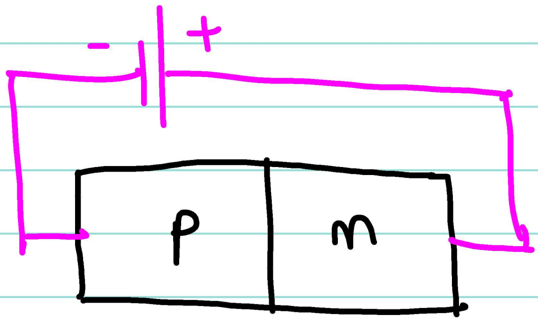
$V_{bi} = 1.107\ V$



A pn junction when it is biased:



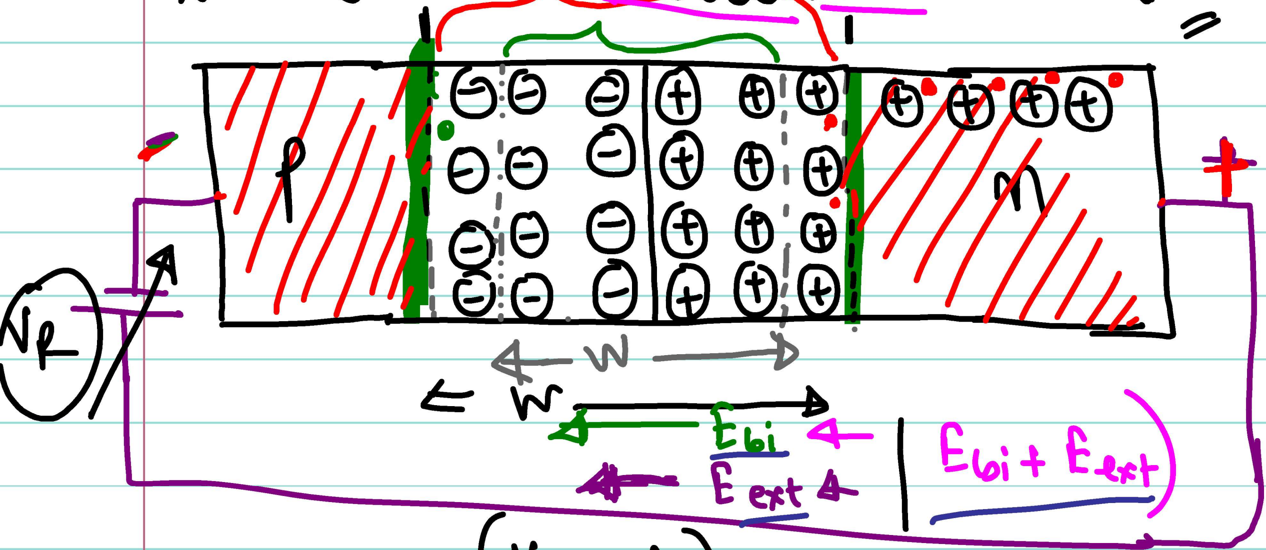
Forward Bias



Reverse Bias

pn junction in Reverse Bias

$$\downarrow C = \frac{\epsilon A}{W}$$

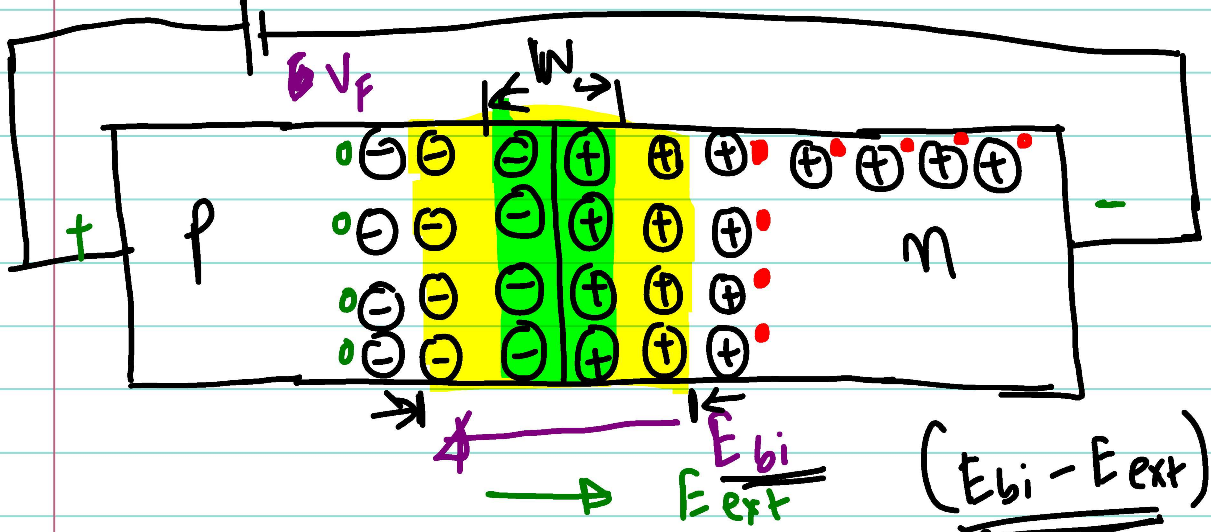


Varactor Diode

$(V = -V_R)$

$$\uparrow W = \left[\frac{2\epsilon (V_{bi} - V)}{q} \left(\frac{N_a + N_d}{N_a N_d} \right) \right]^{1/2}$$

pn junction in forward Bias



$\underline{(E_{bi} - E_{ext})}$; $E_{bi} > E_{ext}$ As.