1.9]

Two Sided PN Junction

$$\phi_{bi} = \phi_t \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

From eq 1.5.1) $\phi_{bi} = \phi_{Fp} - \phi_{Fn}$

From eq 1.2.14 a) $\phi_{Fp} = \phi_t \ln\left(\frac{N_a}{n_i}\right)$

$\phi_{Fn} = -\phi_t \ln\left(\frac{N_d}{n_i}\right)$

$$\phi_{bi} = \phi_t \ln\left(\frac{N_a}{n_i}\right) - \left(-\phi_t \ln\left(\frac{N_d}{n_i}\right)\right)$$

$$\boxed{\phi_{bi} = \phi_t \ln\left(\frac{N_a N_d}{n_i^2}\right)}$$

$$\psi_c = \psi_1 + \psi_2 \rightarrow \text{eq 1.5.11}$$

$$\psi_1 = \frac{q N_D d_1^2}{2\varepsilon_s} \rightarrow \text{eq 1.5.9}$$

$$\psi_2 = \frac{q N_A d_2^2}{2\varepsilon_s} \rightarrow \text{eq 1.5.10}$$

$$\psi_c = \frac{q N_D d_1^2}{2\varepsilon_s} + \frac{q N_A d_2^2}{2\varepsilon_s} = \frac{q N_D d_1^2 + q N_A d_2^2}{2\varepsilon_s}$$

$$\psi_c = \frac{q(N_D d_1^2 + N_A d_2^2)}{2\varepsilon_s}$$

$$\frac{\psi_c 2\varepsilon_s}{q} = N_D d_1^2 + N_A d_2^2$$

$$\frac{d_1}{d_2} = \frac{N_A}{N_D} \rightarrow \text{eq 1.5.7}$$

$$d_1 N_D = d_2 N_A$$

$$\frac{\psi_c 2\varepsilon_s}{q} = N_D d_1^2 + N_A d_2^2 \qquad \frac{d_1}{d_2} = \frac{N_A}{N_D}$$

$$\frac{\psi_c 2\varepsilon_s}{q} = N_D \left(\frac{N_a}{Nd} d_2\right)^2 + N_A d_2^2$$

$$= \frac{N_a^2}{N_D} d_2^2 + N_A d_2^2$$

$$N_D d_1^2 + N_A d_2^2 = \frac{2\varepsilon_s \psi_c}{q}$$

$$N_D \cdot \frac{N_A}{Nd} \cdot d_2 \cdot d_1 + N_A d_2^2$$

$$N_D \quad (N_D + N_A)^2 =$$

$$N_A^2 + N_D^2 + 2N_D N_A$$

$$(N_A \cdot d_2)^2 \cdot \frac{N_A + N_D}{N_D N_A} = \frac{2\varepsilon_S}{q} \psi_C$$

P.1.16

C vs V_R 0-2V n^+p

$A = 200\mu m^2$ $N_A = 5 \times 10^{17} cm^{-3}$

$\phi_{Fn} = -0.56V$ We can replace ϕ_{bi} to be ϕ_{Fn} since its an n^+p

$$C = \frac{1}{A} \cdot \frac{\sqrt{2 \cdot q \cdot \varepsilon_s \cdot N_A}}{2 \cdot \sqrt{V_r + \phi_{Fn}}}$$

Picture attached

3) $V_{DD} = 5V$ $V_{IL} = 1.35V$ $V_{IH} = 3.15V$

$V_{OL} = 0.33V$ $V_{OH} = 3.84V$

$NM_L = V_{IL} - V_{OL} = 1.35V - 0.33 = 1.02V$

$NM_H = V_{OH} - V_{IH} = 3.84V - 3.15V = 0.69V$

We can't tolerate 1.5V noise as our noise margins are below 1.5V

We can tolerate 0.78V on the NM_L but not on the NM_H

4)

A	B	C	Y
0	0	0	1
0	0	1	1
0	1	0	1
1	0	0	1
0	1	1	0
1	0	1	0
1	1	0	0
1	1	1	0

$$Y = \overline{(A+B)(B+C)(A+C)}$$