

VE320 Homework6

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2018-07-20

Ex 6.1

(a)

(i)

$$n_{p0} = \frac{n_i^2}{N_a} = \frac{(1.5 \times 10^{10} \text{ cm}^{-3})^2}{5 \times 10^{16} \text{ cm}^{-3}} = 4.5 \times 10^3 \text{ cm}^{-3}$$

$$p_{n0} = \frac{n_i^2}{N_d} = \frac{(1.5 \times 10^{10} \text{ cm}^{-3})^2}{5 \times 10^{15} \text{ cm}^{-3}} = 4.5 \times 10^4 \text{ cm}^{-3}$$

$$p_n(x_n) = p_{n0} \exp \frac{V_a}{V_t}$$

$$V_a = V_t \ln \frac{p_n(x_n)}{p_{n0}} = V_t \ln \frac{0.1 N_d}{p_{n0}} = 0.599 \text{ V}$$

(ii)

$n_{p0} < p_{n0}$, so n-region concentration is the factor.

(b)

(i)

$$n_{p0} = \frac{n_i^2}{N_a} = \frac{(1.5 \times 10^{10} \text{ cm}^{-3})^2}{7 \times 10^{15} \text{ cm}^{-3}} = 3.214 \times 10^4 \text{ cm}^{-3}$$

$$p_{n0} = \frac{n_i^2}{N_d} = \frac{(1.5 \times 10^{10} \text{ cm}^{-3})^2}{3 \times 10^{16} \text{ cm}^{-3}} = 7.5 \times 10^3 \text{ cm}^{-3}$$

$$n_p(-x_p) = n_{p0} \exp \frac{V_a}{V_t}$$

$$V_a = V_t \ln \frac{n_p(-x_p)}{n_{p0}} = V_t \ln \frac{0.1 N_a}{n_{p0}} = 0.617 \text{ V}$$

(ii)

$n_{p0} > p_{n0}$, po n-region concentration is the factor.

Ex 6.2

(a)

$$J_s = en_i^2 \left(\frac{1}{N_a} \sqrt{\frac{D_n}{\tau_{n0}}} + \frac{1}{N_d} \sqrt{\frac{D_p}{\tau_{p0}}} \right) = 5.145 \times 10^{-11} \text{ A/cm}^2$$

$$I_s = AJ_s = 2 \times 10^{-4} \text{ cm}^2 \cdot 5.145 \times 10^{-11} \text{ A/cm}^2 = 1.029 \times 10^{-14} \text{ A}$$

(b)

(i)

$$I = I_s \exp \frac{V_a}{V_t} = 1.029 \times 10^{-14} \text{ A} \exp \frac{0.45 \text{ V}}{0.0259 \text{ V}} = 3.615 \times 10^{-7} \text{ A}$$

(ii)

$$I = I_s \exp \frac{V_a}{V_t} = 1.029 \times 10^{-14} \text{ A} \exp \frac{0.55 \text{ V}}{0.0259 \text{ V}} = 1.717 \times 10^{-5} \text{ A}$$

(iii)

$$I = I_s \exp \frac{V_a}{V_t} = 1.029 \times 10^{-14} \text{ A} \exp \frac{0.65 \text{ V}}{0.0259 \text{ V}} = 8.160 \times 10^{-4} \text{ A}$$

Ex 6.3**Ex 6.4**

$$\frac{I_f}{I_s} = \exp \frac{V_a}{V_t}$$

$$V_t = \frac{V_a}{\ln(I_f/I_s)} = \frac{0.5 \text{ V}}{\ln 2^4} = 5.049 \times 10^{-2} \text{ V}$$

$$T = \frac{300V_T}{0.0259} = 5.848 \times 10^2 \text{ K}$$