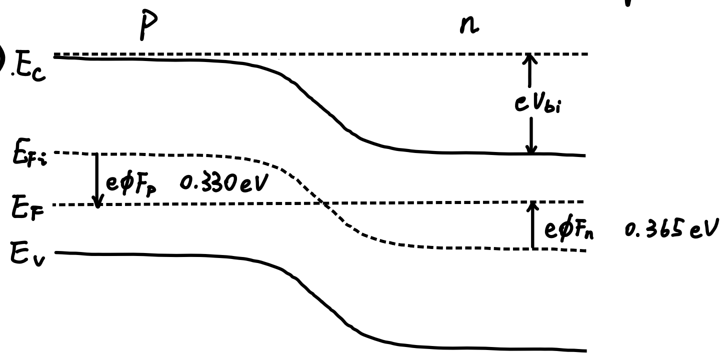
VE320 HW6 周[illegible] 518021911039

1. (a)



(b). $N_a = n_i \exp\left(\frac{E_{Fi} - E_F}{kT}\right) = 5.12 \times 10^{15}\ cm^{-3}$

$N_d = n_i \exp\left(\frac{E_F - E_{Fi}}{kT}\right) = 1.97 \times 10^{16}\ cm^{-3}$

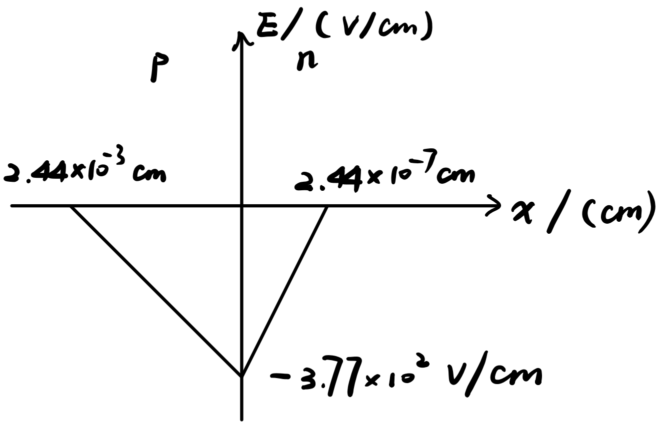
(c). $V_{bi} = V_t \ln\left(\frac{N_a N_d}{n_i^2}\right) = 0.69\ V$

2. (a). $V_{bi} = V_t \ln\left(\frac{N_a N_d}{n_i^2}\right) = 0.46\ V$

(b). $x_n = \sqrt{\frac{2\varepsilon V_{bi}}{q} \cdot \frac{N_a}{N_d} \cdot \frac{1}{N_a + N_d}} = 2.44 \times 10^{-7}\ cm$

(c). $x_p = \sqrt{\frac{2\varepsilon V_{bi}}{q} \cdot \frac{N_d}{N_a} \cdot \frac{1}{N_a + N_d}} = 2.44 \times 10^{-3}\ cm$

(d). $|E_{max}| = \frac{e N_a x_p}{\varepsilon} = 3.77 \times 10^{2}\ V/cm$



3. (a).

$$x_p = \sqrt{\frac{2\varepsilon_s V_R}{e N_a}}$$

$$50\times10^{-4} = \sqrt{\frac{2\times11.7\times8.85\times10^{-4}\, V_R}{1.6\times10^{-19}\times10^{14}}}$$

$$V_R = 193.15\ V$$

(b). $x_n = x_p \frac{N_a}{N_d} = 5\times10^{-5}\ cm$

(c). $|E_{max}| = \frac{2V_R}{W} = 7.65\times10^{4}\ V/cm$

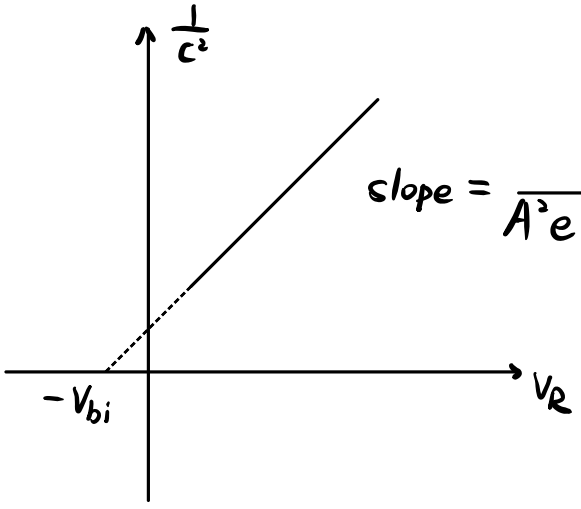
4. (a). $V_{bi} = V_t \ln\left(\frac{N_a N_d}{n_i^2}\right) = 0.0259 \ln\left(\frac{2\times10^{17}\times2\times10^{15}}{(1.5\times10^{10})^2}\right) = 0.73\ V$

(b). (i). $C \approx A\sqrt{\frac{e\varepsilon_s N_d}{2(V_{bi}+V_R)}} = 9.79\times10^{-14}\ F$

(ii). $C \approx A\sqrt{\frac{e\varepsilon_s N_d}{2(V_{bi}+V_R)}} = 6.66\times10^{-14}\ F$

(iii). $C \approx A\sqrt{\frac{e\varepsilon_s N_d}{2(V_{bi}+V_R)}} = 5.38\times10^{-14}\ F$

(c). $\frac{1}{C^2} = \frac{2(V_{bi}+V_R)}{A^2 e\varepsilon_s N_d}$



$$slope = \frac{2}{A^2 e\varepsilon_s N_d} \Rightarrow N_d = \frac{2}{A^2 e\varepsilon_s \times slope}$$

5(a). (i). $n_{p_0} = \frac{n_i^2}{N_a} = \frac{(1.5\times10^{10})^2}{5\times10^{16}} = 4.5\times10^{3}\ cm^{-3}$

$P_{n_0} = \frac{n_i^2}{N_d} = \frac{(1.5\times10^{10})^2}{5\times10^{15}} = 4.5\times10^{4}\ cm^{-3}$

$V_a = V_t \ln\left(\frac{0.1\,N_d}{P_{n_0}}\right) = 0.059 \ln\left(\frac{0.1\times5\times10^{15}}{4.5\times10^{4}}\right) = 0.60\,V$

(ii). n-region

(b). (i). $n_{p_0} = \frac{n_i^2}{N_a} = 3.21\times10^{4}\ cm^{-3}$

$P_{n_0} = \frac{n_i^2}{N_d} = 7.5\times10^{3}\ cm^{-3}$

$V_a = V_t \ln\left(\frac{0.1\,N_a}{n_{p_0}}\right) = 0.62\,V$

(ii). p-region