EC233
ELECTRONIC DEVICES 1

SHEET 7 SOLUTIONS-PART 2

PROBLEM 2

- Figure (1) presents an energy band diagram of an abrupt silicon pn junction. Let the sample be maintained at 300 K and $N_a = 5x10^{15}cm^{-3}$. Use the cited energy band diagram to answer the following three parts:

i. What is the bias condition of the diode? Justify
ii. Find the doping concentration N_D at in the $x > x_n$ region.
iii. Calculate the ration x_p/w .

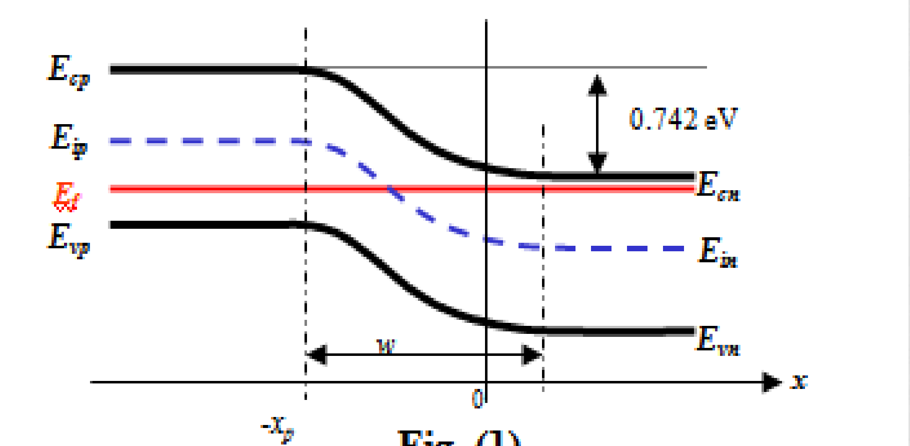


Fig. (1)

PROBLEM 2

i. What is the bias condition of the diode? Justify

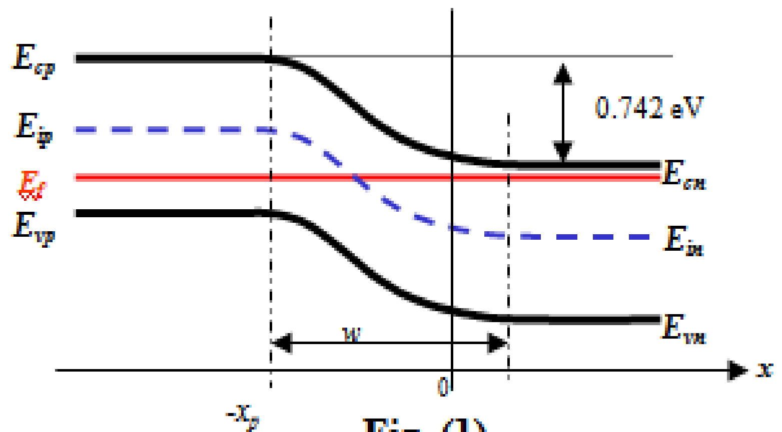


Fig. (1)

Thermal Equilibrium (E_f constant with space)

PROBLEM 2

ii. Find the doping concentration N_D at in the $x > x_n$ region.

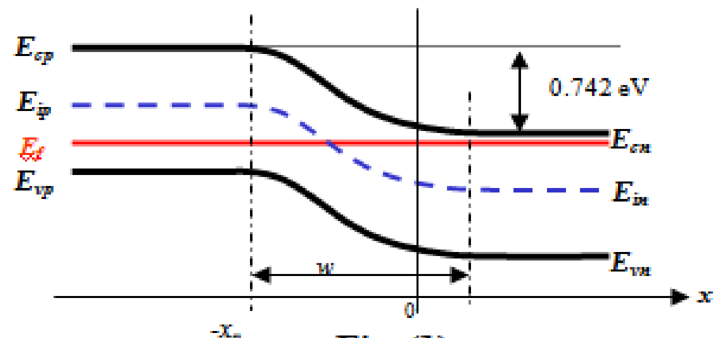


Fig. (1)

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

Givens:

- $N_a = 5x10^{15} cm^{-3}$
- At T=300K: $\frac{KT}{q} = 0.0259V$, in Silicon: $n_i = 1.5x\ 10^{10} cm^{-3}$

Solution:

$$N_d = \frac{n_i^2}{N_a}\ e^{\frac{qV_{bi}}{kT}}$$

PROBLEM 2

iii. Calculate the ration x_{po}/w .

Recall from space charge neutrality:

$$N_a x_{po} = N_d x_{no}$$

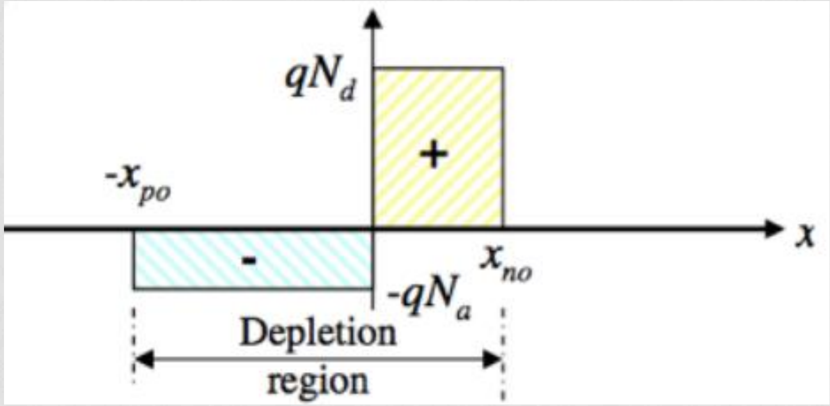
$$\frac{x_{no}}{x_{po}} = \frac{N_a}{N_d}$$

$$\frac{x_{no}}{x_{po}} + 1 = \frac{N_a}{N_d} + 1$$

$$\frac{x_{no} + x_{po}}{x_{po}} = \frac{N_a + N_d}{N_d}$$

$$\frac{x_{po}}{x_{no} + x_{po}} = \frac{N_d}{N_a + N_d}$$

$$\frac{x_{po}}{W} = \frac{N_d}{N_a + N_d}$$



PROBLEM 4

A Si^+ p-n that is10 cm^2 in area has $N_D = 10^{15}$ cm^{-3} in the n-side. Draw the energy band diagram in the thermal equilibrium condition of such junction indicate the following on it after calculation:

a) $(E_{fn}-E_i)$ in ev.
b) qV_{bi} if $E_i-E_{fp} = 0.555$ eV

Solution:

a) Recall $n = n_i \exp[(E_F - E_i)/kT]$

$$E_{Fn} - E_i = KT \ln(\frac{N_d}{n_i}) = 0.288\text{eV}$$

b) qVbi=0.288+0.555=0.843e.V.