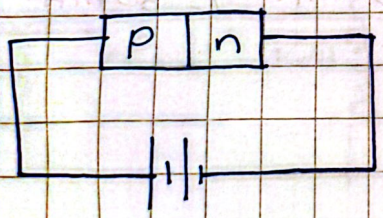
Assignment 2.1 – Semiconductor Basics

① n-Type semiconductors have more electrons than the holes. This n-Type semiconductors are made by dopping with the atoms having extra electrons. Pure silicon is stable, but when it dopped with a phosperous which has five valence electrons, the Silicon bonds with Phosperous with 4 electrons and one eletron is getting free. So by this dopping electrons become majority carriers.

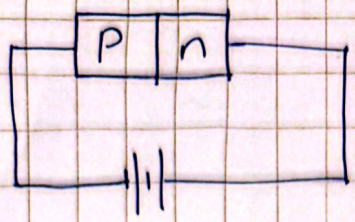
P-type semiconductors have holes more than electrons. This p-type semiconductors make by dopping the atoms lacking one electron. When Silicon dopped with Boron they made bond but Boron has only three velance electrons. So there is one hole ~~exsist~~ remains. So by dopping this way the majority becomes holes.

② Forward-biase P-n juction dicde



In forward-bias the positive terminal of power source is connected to p side of dicde & the negative terminal of power source is connected to n side of dicde. The depletion region becomes narrow and barrier potential is reduced. The result is large current flows through the dicde.

Reverse - bias p-n junction diode.



p side is connected to negative terminal of power source and n side is connected to positive terminal of power source. The depletion region become wider & barrier potential increases. ~~Rest~~ Result is diode blocks current and used for protection.

③ If consider a ideal diode, it has a zero voltage drop in forward bias, but practically it need 0.7 V for silicon diode (knee voltage) untill ~~it~~ ~~is~~ current increases rapidly. So ideal device is a theoritical model, like it works perfectly, no losses, respend instantly.

④ a) For the thermal voltage in temperature 25°C

$$V_T = \frac{kT}{q}$$

$k = 1.38 \times 10^{-23}$ J/K T = temperature in kelvin

q = charge of a electron (1.602×10^{-19} C)

$T = 273° + 25 = 298$ K

So: $V_T = \frac{kT}{q}$

$$= \frac{1.38 \times 10^{-23} \text{ J/K} \times 298 \text{ K}}{1.602 \times 10^{-19} \text{ C}}$$

$= 0.0256$ V

$= 25.6$ mV

b) $I_D = I_S \left(e^{V_D/nV_T} - 1\right) \rightarrow ①$

$I_{Ss} = 40\,nA$

$V_D = 0.5\,V$

$V_T = 25.6\,mV$

$n = 2$

So substitute these values to equation ①

$I_D = 40\times10^{-9}\,A \left(e^{0.5/2(25.6\times10^{-3})} - 1\right)$

$I_D = 40\times10^{-9} \left(e^{500/51.2} - 1\right)$

$I_D = 40\times10^{-9} \left(e^{9.765} - 1\right)$

$I_D = 40\times10^{-9} \left(1.7413\times10^{4} - 1\right)$

$I_D = 40\times10^{-9} \left(17412.48\right)$

$I_D = 6.964\times10^{-4}\,A$

$I_D = 0.6964\,mA$ //