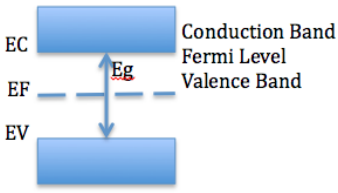
Phys 417 Homework on Semiconductors

#1. Find the energy gap Eg for Si, Diamond, and Germanium at room temperature 300K°. The Fermi energy level EF is generally considered to be midway between the top of the valence band EV and the bottom of the conduction band EC.



C: 5.47 eV
Si: 1.12 eV
Ge: 0.66 eV

#2. What is the wavelength $\lambda(nm)$ of light that would excite an electron from the valence to conduction band in Silicon, Diamond, and Germanium?

C: 5.47 eV E = (1240/5.47) nm = 227 nm
Si: 1.12 eV E = (1240/1.12) nm = 1103 nm
Ge: 0.66 eV E = (1240/0.66) nm = 1880 nm

#3. Determine the number density of intrinsic charge carriers $\mathbf{n_i}$ **(#/cc)** in silicon at room temperature T=300°K.

$\boxed{n_i^2 = n \cdot p}$ *where* $n = \#electrons/cc$ $p = \#holes/cc$ *number density*

$$n = p \cong 2\left(\frac{2\pi m^* kT}{h^2}\right)^{3/2} e^{-\frac{|E_{C/V} - E_F|}{kT}} = 2\left(\frac{6.28x(9.11x10^{-31}kg)(300Kx1.38x10^{-23}m^2kgs^{-2}K^{-1})}{(6.626x10^{-34}J-s]^2}\right)^{3/2} \times e^{-\frac{0.56}{1/40}}$$

$$n = p = 2\left(\frac{2\pi m^* kT}{h^2}\right)^{3/2} e^{-\frac{|E_C - E_F|}{kT}} = 2.5x10^{19}cm^{-3}\ x1.9x10^{-10} = \boxed{4.8x10^9\,cm^{-3}}$$

#4. The Shockley diode current follows the ideal equation $I = I_0(e^{eV/kT} - 1)$. At room temperature kT=1/40 eV. (T=300oK). V is the applied voltage. The reverse bias saturation current I_o, is the diode current when V = -∞. Assume I_o =10^{-12}A=1pA. Use Excel or similar to graph the current I vs V curve for values of V between 0 and 1 volt in 0.1 interval steps. Label the axes. Provide the current and voltages in a table.

V(volts)	I(amps)
0.0001	1.004E-12
0.1	5.460E-11
0.2	2.981E-09
0.3	1.628E-07
0.4	8.886E-06
0.5	4.852E-04
0.6	2.649E-02
0.7	1.446E+00
0.8	7.896E+01
0.9	4.311E+03
1	2.354E+05