EEGR 215 Materials & Devices
Lab 2
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With the help of a computer and a commercial software package such as Matlab to solve the following problems:

1. Write a Matlab program to confirm that the n_i versus T curve for Ge and Si graphed in Figure 2.20 can be generated by employing the empirical fit relationships below. Check over the temperature range of 275K ≤ T ≤ 375K.

$$n_i(Si) = \left(9.15\times10^{19}\right)\left(\frac{T}{300}\right)^2 e^{-0.5928/kT} \qquad \text{eqn. 1}$$

$$n_i(Ge) = \left(1.76\times10^{16}\right)\left(T\right)^{3/2} e^{-0.392/kT} \qquad \text{eqn. 2}$$

2. Generate a MATLAB program to compute and plot the Fermi function, f(E), and 1- f(E) versus $\Delta E = E-E_f$ for values of ΔE that is over the range of $-0.5eV \le \Delta E \le 0.5eV$ for varying temperature settings where Temperature = 150, 250, 350, 450 and 550K. Make sure that each f(E) versus ΔE curve at each temperature is superimposed on the same plot. Discuss what you see in your plots as the Fermi function, f(E), and 1-f(E) varies with temperature and energy.

3. Consider GaAs at T = 300K with N_d =0. (a) Plot the position of the Fermi energy level with respect to the intrinsic Fermi energy level as a function of the acceptor impurity concentration over the range of $10^{14} \le Na \le 10^{17}$ cm^{-3}. (b) Plot the position of the Fermi energy level with respect to the valence-band energy over the same acceptor impurity concentration given in part (a).

4. The temperature of a sample of Ge is T = 300K and the acceptor doping concentration is N_a = 0. Plot the minority carrier concentration (on a log-log plot) versus Nd over the range $10^{15} \le Nd \le 10^{18}$ cm^{-3}