HW #2
Due September 25 (Thursday) in class

1. Calculate the absorption coefficient of GaAs at 300 K as a function of the photon energy, from 1 to 2 eV, using material parameters listed in Appendix K of Chuang’s textbook (pp. 708-711). For the hole effective mass, use that of the heavy hole. Assume effective mass approximation (parabolic E-k relation). Superimpose your plot on the data shown below, and observe how well they match. (Digitize the absorption curve below so you can include them in your plotting program. Alternatively, you can compare your calculated data with the values listed in Table J.1 on p. 703 in Chuang).

2. Refer to the diagram below. Under biased condition, both conduction and valence bands are populated. The electron distribution in conduction band is described by Fermi-Dirac distribution, $f_C(E_2)$, with quasi-Fermi energy $F_C$. The electron distribution in valence band is described by Fermi-Dirac distribution, $f_V(E_1)$, with quasi-Fermi energy $F_V$. Here, $E_1$ and $E_2$ are related by an optical transition (i.e., they have the same $k$).
a. Use the energy reference below (i.e., $E_V = 0$ and $E_C = E_g$, the bandgap energy), find $E_1$ and $E_2$ as functions of the photon energy, $\hbar \omega$.

b. Derive $f_C(E_2(\hbar \omega))$ as a function of $\hbar \omega$.

c. Derive $f_V(E_i(\hbar \omega))$ as a function of $\hbar \omega$.

d. Assuming $E_g = 1$ eV, $F_C - F_V = 1.2$ eV, $m^*_e = 0.1m_0$, $m^*_h = 0.4m_0$. Calculate and plot the emission probability $f_i(\hbar \omega) = f_C(E_2(\hbar \omega)) \cdot [1 - f_V(E_i(\hbar \omega))]$ for photon energies from 0.8 to 1.5 eV. Plot for two temperatures: $T = 0$ and $T = 300$ K.

e. Repeat part d) for the Fermi inversion factor: $f_g(\hbar \omega) = f_C(E_2(\hbar \omega)) - f_V(E_i(\hbar \omega))$.

![Diagram of energy levels](image-url)