Problem 1. Answer the following questions:

A. Is the mobility in intrinsic semiconductors higher or lower than in heavily doped semiconductors?
B. An average hole drift velocity of $10^3 \text{cm/s}$ results when $2\text{V}$ is applied across a $1\text{-cm-long semiconductor bar}$. What is the hole mobility inside the bar?
C. Determine the resistivity of intrinsic Ge, Si, and GaAs at $300\text{K}$. Use Figs. 2.20 and 3.5 from the textbook to answer this question.

Problem 2. Determine the maximum value of the resistivity of silicon that you can obtain by changing the doping concentration at room temperature. Is the maximum value equal to the intrinsic resistivity? (No numerical answer is required)

Problem 3. The Fermi level in a Si sample maintained at $T = 300\text{K}$ is located at $E_c - \frac{E_g}{4}$.

A. Show that the semiconductor is nondegenerate.
B. Plot the electron distribution in the CB (number of electrons/cm$^3$/eV) as a function of the energy.
Use: $E_g = 1.12\text{eV}$, $kT = 0.026\text{eV}$, $m^*_e = 1.18m_0$, $m_0 = 9.1\times10^{-31}\text{Kg}$, $h = 6.63\times10^{-34}\text{Js} = 4.14\times10^{-13}\text{eV s}$.

Problem 4. Consider a doped nondegenerate semiconductor at thermal equilibrium. Denote the acceptor doping concentration by $N_A$ and the donor doping concentration by $N_D$.

A. Find the position of the Fermi level as a function of $E_c$ and $N_c$.
B. Use the formula found in part A to show that, if $N_D \gg N_A$ and $N_D \gg n_i$ then:

$$E_F \approx E_c + kT \ln \left[ \frac{N_D}{N_c} \right].$$