1. [2] Find values of the intrinsic carrier concentration $n_i$ for silicon at $-70^\circ C, 0^\circ C, 20^\circ C, 100^\circ C$, and $125^\circ C$. Also, at each temperature, what fraction of the atoms are ionized? Recall that a silicon crystal has approximately $5 \times 10^{22}$ atoms/cm$^3$

2. [2] In a phosphorous-doped silicon layer with impurity concentration of $10^{16}$/cm$^3$, find the hole and electron concentration at $25^\circ C$ and $125^\circ C$.

3. [2] An avalanche-breakdown diode, for which the breakdown voltage is 12V, has a rated power dissipation of 0.25W. What continuous operating current will raise the dissipation to half the maximum value.
4. [2] At what temperature will intrinsic silicon become a conductor based on the definitions in Table 2.1? Assume that $\mu_n = 100\text{cm}^2/\text{V.S}$ and $\mu_p = 50\text{cm}^2/\text{V.S}$. (Note that silicon melts at 1430K)

5. [2] GaAs is composed of equal numbers of atoms of gallium and arsenic in a lattice similar to that of silicon. (a) Suppose a silicon atom replaces a gallium atom in the lattice. Do you expect the silicon atom to behave as a donor or acceptor impurity? Why? (b) Suppose a silicon atom replaces an arsenic atom in the lattice. Do you expect the silicon atom to behave as a donor or acceptor impurity? Why?
6. [2] Silicon is doped with an acceptor concentration of $10^{18}/cm^3$. Find the electron and hole concentrations, the electron and hole mobilities, and the resistivity of this silicon material at 300K. Is this material $n$ or $p$ type?

7. [2] Fig. 7 shows a diode circuit. The diodes are identical with $n = 1$, and $I_s = 10^{-14}$. Find the value of the current $I$ required to obtain an output voltage $V_o = 2V$. If a current of 1mA is drawn away from the output terminal by a load, what is the change in output voltage?

All diodes are identical.
8. [2] Use the iterative-analysis procedure to determine the diode current and voltage in the circuit for \( V_{DD} = 1V, R = 1k\Omega \), and a diode having \( I_S = 10^{-15}A \) and \( n = 1 \). (You can turn in an Excel/MATLAB printout)

\[
\begin{align*}
\text{\( R \)} & \quad \text{\( I_D \)} \\
\text{\( + \)} & \quad \text{\( \text{\( V_{DD} \)} \)} \\
\text{\( \text{\( V_D \)} \)} & \quad \text{\( - \)}
\end{align*}
\]

9. [2] At what forward voltage does a diode for which \( n = 2 \) conduct a current equal to 1000\( I_S \)? In terms of \( I_S \), what current flows in the same diode when its forward voltage is 0.7V?
10. [2] (a) $R_1 = 5k\Omega$, $R_2 = 10k\Omega$. Assume the diodes are ideal. Find $V$ and $I$. (b) $R_1 = 10k\Omega$, $R_2 = 5k\Omega$. Assume the diodes are ideal. Find $V$ and $I$. 