Problem 1 (25 points)
Consider a silicon semiconductor doped with $N_A = 2x10^{14}$ cm^{-3}. Assume $E_g = 1.12$eV, $n_i = 1.5x10^{10} cm^{-3}$, kT = 0.026eV at T=300K.

$$\mu_n = 1350\left(\frac{T}{300}\right)^{-\frac{3}{2}} cm^2/V.s,\ \mu_p = 480\left(\frac{T}{300}\right)^{-\frac{3}{2}} cm^2/V.s$$

a) (10 points) Determine the conductivity at T = 300K.

b) (10 points) Determine the conductivity at T = 500K.

c) (5 points) Determine the conductivity at T = 0K.

Problem 2 (25 points)

Assume the density of states in the conduction band for a given semiconductor is equal to $g_c(E) = K$, where $K = 10^{19}$ cm^{-3}. $T=300K$, $kT = 0.026eV$.

a) (5 points) Write the procedure for finding the density of electrons in the conduction band assuming the Boltzmann approximation.

b) (10 points) Determine n_0 as a function of E_C , E_F, and T.

c) (10 points) Assume E_F is 5kT below E_C, determine a value of n_0.

Problem 3 (25 points)

The electron concentration in silicon is $n_0 = 10^7$ cm^{-3}. $n_i = 1.5x10^{10} cm^{-3}$, T = 300K, kT = 0.026eV.

a) (5 points) Is the material n-type or p-type? Why?

b) (5 points) Determine p_0

c) (5 points) Determine $E_F - E_{Fi}$

d) (10 points) If $N_D = 10^{14}$ cm^{-3}, determine N_A

Problem 4 (25 points)

Consider an intrinsic silicon semiconductor with a cross section area of 1μm x 1μm and a length of 10μm. A voltage of 5V is applied across the sample.
Assume $n_i = 1.5x10^{10} cm^{-3}$, T = 300K, kT = 0.026eV, μ_n = 1350 cm^2/V.s, μ_p = 480 cm^2/V.s

a) (10 points) Determine the current.

b) (5 points) Determine the average electron and hole velocities.

c) (10 points) Determine the current if the semiconductor is doped with N_D =5x 10^{16} cm^{-3}