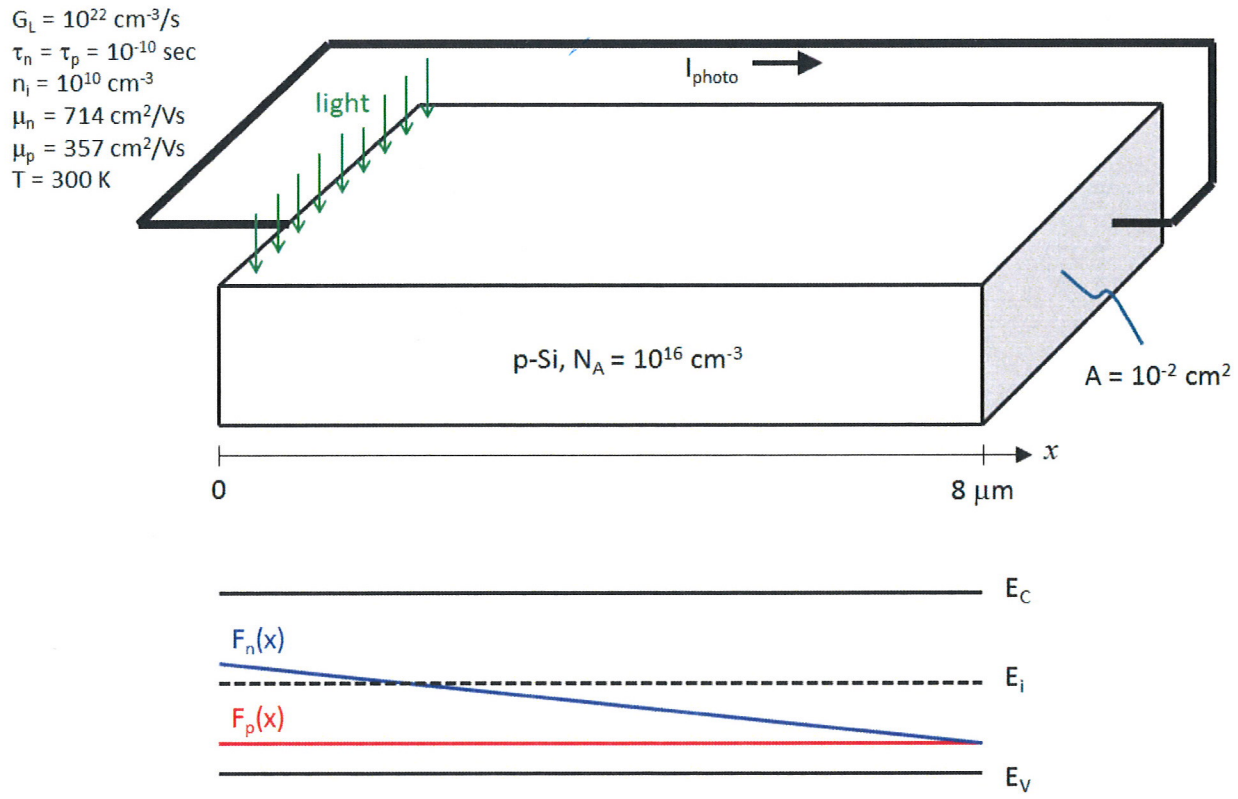
Problem 5, Semiconductor Materials

Consider the structure below:



Assume that the sample is p-type Si with acceptor doping concentration, $N_A = 10^{16}$ cm^{-3} and is illuminated such that a generation rate, G_L of 10^{22} cm^{-3}/s occurs at $x = 0$. (Assume that all of the light is absorbed at $x = 0$ and no generation occurs anywhere else in the sample. The values of the electron and hole minority carrier recombination times (τ_n, τ_p), intrinsic carrier concentration (n_i), electron and hole mobilities (μ_n and μ_p) and temperature, T, are listed above). A current flows between ideal contacts at either end of the sample and the above band diagram results due to the illumination. Assume that the electric field is zero throughout the sample.

(a) Calculate the electron and hole quasi-Fermi-level energies, F_n, and F_p, relative to the intrinsic Fermi energy, E_i, at $x = 0$. Two significant digits are sufficient for this answer (1.0 pt)

(b) Based upon the band diagram, what is the electron current, $I_n(0)$ at $x = 0$? Assume positive current flows in the same direction as I_{photo} shown in the figure. (1.0 pt)

(c) What is the value of the electron diffusion coefficient, D_n? (1.0 pt)

(d) Assuming that the electron and hole currents are equal at $x = 0$ (i.e., $I_n(0) = I_p(0)$), what is the slope of the hole quasi-Fermi-level, dF_p/dx, at $x = 8$ μm? (1.0 pt)