1) Holes are injected and extracted in to an n-doped semiconductor at \( x = 0 \) as shown in the figure below. However, the doping is not perfectly uniform such that there is a small internal electric field \( E \). Assume that the semiconductor is maintained in the dark and with low level recombination and the right end is contacted with a metal.

a. Obtain an expression for the excess hole density in terms of \( \Delta p(x=0) \) and at steady state condition

b. Assuming that the minority carrier lifetime is 100ns and the hole mobility is 400 \( \text{cm}^2/\text{Vs} \), compute the drift and diffusion current. You can assume that \( L=10 \text{mm} \), \( \Delta p(x=0) = 1\times10^{15}/\text{cm}^3 \) and \( E=10\text{V/cm} \) at \( x=0 \).

![Figure of n-type semiconductor]

2) Solve ASF 5.10

3) Calculate the resistivity of intrinsic silicon at room temperature. Further, assume that this piece of intrinsic silicon is now n-doped with a concentration equal to \( 10^{16}/\text{cm}^3 \). Compute the resistivity for the n-type silicon

4) A semi-infinite n-type semiconductor bar is subject to uniform penetrating illumination resulting in a generation rate of \( G \) electron-hole pairs per second per cm\(^2\) throughout the bar. \( G \) is such that sample remains in low-level injection. Minority carriers are extracted at the surface at \( x = 0 \). Obtain an expression for the maximum hole current that can be drawn from the bar in steady-state.

5) Consider a region in a semiconductor that is totally depleted of carriers \((n=p=0)\). Obtain an expression for the energy level of the RG centers relative to mid-gap \( \Delta E = (E_T - E_i) \) that results in the highest possible generation rate. Your answer should include the minority carrier lifetimes.