ECE 305 – Spring 2018

Homework 6 – Due Tuesday, February 27, 2018 at 12:00 PM in class (or EE 326B)

1. Consider a crystalline silicon n-p homojunction at room temperature ($T = 300$ K). The n-type region has $N_D = 10^{15}$ /cm^3, minority carrier $\mu_p = 450$ cm^2/V · s, minority carrier $\tau_p = 1$ µs, and width $W_n = 10$ µm, while the p-type region has $N_A = 10^{17}$ /cm^3, minority carrier $\mu_n = 1400$ cm^2/V · s, minority carrier $\tau_n = 2$ µs, and $W_p = 420$ µm. Assume the dopants are fully ionized.
    a. Find the dark current per unit area J_o.
    b. Using the ideal diode equation, find the current per unit area $J(V_A)$.
    c. At voltages of $V_A = -0.4$ V and $V_A = 0.4$ V, how much power will the diode consume per unit area? Why are these values so different?

2. Assume that the ideal diode equation is modified such that $J = J_o\left(e^{qV_A/nkT} - 1\right)$, where n is the ideality factor.
    a. Calculate the applied voltage V_A required to reach a current density of 10 mA/cm^2 as a function of ideality factor n, for values between 1 and 2.
    b. Assuming the data in the graph below is taken at room temperature, estimate the ideality factor for voltages from 0.1-0.45 V (red dots). Is this value realistic? Justify your answer.