ECE 305 – Spring 2018

Homework 8 – Due Tuesday, March 27, 2018 at 12:00 PM in class (or in EE 326B)

1. Consider the following data for a p^+-n junction diode with an abrupt doping profile and a cross-sectional area of 0.3 mm^2. Voltages are in volts, and capacitances are in picofarads.

V_A	C		V_A	C		V_A	C
0	35.7		-1.8	18.5		-7.0	10.8
-0.2	30.7		-2.2	17.3		-8.0	10.2
-0.4	27.6		-2.6	16.2		-9.0	9.6
-0.6	25.3		-3.0	15.4		-10.0	9.2
-0.8	23.6		-4.0	13.8		-11.0	8.7
-1.0	22.2		-5.0	12.5		-12.0	8.4
-1.4	20.1		-6.0	11.6		-15.0	7.5

   a. Use this data to create a linear plot of $1/C^2$ versus V_A, including a best-fit line.

   b. Use the intercept of the best-fit line with the x-axis to estimate V_{bi}.

   c. Estimate the slope, and then the n-type region donor concentration N_D.

2. A metal-semiconductor (Schottky) diode is formed from n-type crystalline silicon. Assume that the device has a built-in voltage $V_{bi} = 0.7$ eV at room temperature. Furthermore, assume that it is uniformly illuminated by solar photons, such that $G_L = 2.5 \cdot 10^{19} \mathrm{cm}^{-3}\mathrm{s}^{-1}$ in a silicon thickness of 100 μm (the metal thickness is negligible).

   a. If the diode terminals are in short-circuit condition (i.e., the net voltage across the terminals vanishes), sketch the band diagram.

   b. If the diode terminals are in open-circuit condition (i.e., the net current across the terminals vanishes), sketch the band diagram.

   c. Calculate the photocurrent flowing in the MS photodiode at zero bias. Hint: use the simplified procedure outlined in Section 9.2.1 of SDF, and assume that the p-type doped region has zero thickness.

   d. Sketch the total current density (current per unit area) of the illuminated MS photodiode as a function of applied voltage V_A, from 0 to V_{oc}.