HW7

1. Consider an abrupt silicon p-n junction of cross sectional area A. The p-side is doped with $N_a$ acceptors per cm$^3$ and the n-side is doped with $N_d$ donors per cm$^3$. Suppose the device is under a forward bias voltage $V$.

(a) Starting with the definition of capacitance in a medium where positive and negative charges are separated, derive an expression for the capacitance of this p-n junction when the bias voltage $V$ is applied.

(b) Calculate the capacitance for $N_d = 5 \times 10^{16}$ cm$^{-3}$ and $N_a = 1 \times 10^{17}$ cm$^{-3}$, junction cross section of $1 \times 10^{-4}$ cm$^2$, and applied voltage of 1.2 volts.

(c) Calculate the capacitance for a similar device where the donor concentration is the same as above but the p-side is heavily doped (p$^+$-n junction).

(d) Sketch a diagram for the rectangular device in part (c) and using the diagram explain why the acceptor concentration on the p$^+$ side is not needed for the calculation of the junction capacitance. Assume the charges in the depletion region are separated similar to a parallel-plate capacitor $C = \varepsilon A / w$.

2. Look up and list the important specifications and price of a device in each of the following categories:

(a) A Zener diode
(b) An Avalanche Photo Detector diode (APD)
(c) A Varactor