PSC Assignment -5

5.1 Consider a silicon *pn* junction at T = 300 K with doping concentrations of Na = $10^{16}/cm^3$ and Nd = $10^{15}/cm^3$. Calculate the built-in potential, space charge width and maximum electric field in the junction for zero bias. Assume that ni = 1.5×10^{10} $/cm^3$.

5.2 Again, consider a silicon pn junction at T = 300 K with doping concentrations of Na = 10^{16} $/cm^3$ and Nd = 10^{15} $/cm^3$. Calculate the width of the space charge region in the junction when a reverse biased voltage of 5 V is applied.

5.3 Consider the same pn junction as that in Ex5.2. Calculate the junction capacitance of a pn junction. Again, assume that V_R = 5 V.

5.4 Determine the impurity doping concentrations in a p^+n junction given the parameters from $1/C^2$ versus V plot. Given that the intercept and the slope of the curve are Vbi = 0.725 V and 6.15 x 10^{15} $(F/cm^2)^{-2}$ $(V)^{-1}$, respectively, for a silicon p^+n junction at T = 300 K.

5.5 A one-sided, planar, uniformly doped silicon pn junction diode is required to have a reverse-biased breakdown voltage of VB = 60 V. What is the maximum doping concentration in the low-doped region such that this specification is met?

5.6 A silicon pn junction in thermal equilibrium at T = 300 K is doped such that E_F - E_{Fi} = 0.365 eV in the n region and E_{Fi} - E_F = 0.330 eV in the p region. (a) Sketch the energy-band diagram for the pn junction. (b) Find the impurity doping concentration in each region. (c) Determine Vbi.

5.7 Consider a uniformly doped silicon pn junction at T = 300 K. At zero bias, 25 percent of the total space charge region is in the n-region. The built-in potential barrier is Vbi = 0.710 V. Determine (i) Na, (ii) Nd, (iii) xn, (iv) xp, and (v) |Emax|.

5.8 An ideal one-sided silicon p^+n junction at T = 300 K is uniformly doped on both sides of the metallurgical junction. It is found that the doping relation is Na = 80 Nd and the built-in potential barrier is Vbi = 0.740 V. A reverse-biased voltage of VR = 10 V is applied. Determine (a) Na, Nd; (b) xp, xn; (c) Emax ; and (d) C_j.

5.9 A silicon p^+n junction has doping concentrations of Na = 2×10^{17} cm^{-3} and Nd = 2×10^{15} cm^{-3}. The cross-sectional area is 10^{-5} cm^2

. Calculate (a) Vbi and (b) the junction capacitance at (i) VR = 1 V, (ii) VR = 3 V, and (iii) VR = 5 V. (c) Plot $1/C^2$ versus VR and show that the slope can be used to find Nd and the intercept at the voltage axis yields Vbi

5.10 Consider a silicon n^+p junction diode. The critical electric field for breakdown in silicon is approximately Ecrit = 4×10^5 V/cm. Determine the maximum p-type doping concentration such that the breakdown voltage is (a) 40 V and (b) 20 V.