ECSE-2210 Microelectronics Technology
Homework 9

Reading list: Chapters 14 (pages 477 – 487). Hand in your solutions in class.

1. Assume that an ideal Schottky barrier is formed on n-type Si having $N_D = 10^{16}$ cm^{-3}. The metal work function is 4.5 eV, and the Si electron affinity is 4.0 eV.

   (a) Draw equilibrium band diagrams such as in Fig 14.2 to scale. What is the barrier height $q\,V_{bi}$ (where V_{bi} is called the built-in voltage) for electron flow from the semiconductor to metal (S → M)? What is the barrier height (Φ_B) for electron flow from the metal to semiconductor (M → S)? What is the depletion layer width formed in the semiconductor? What is the maximum electric field $\mathcal{E}_0$ in the depletion layer?

   (b) Draw to scale the forward- and reverse-bias band diagrams, as in Fig 14.3, for $V_A = 0.1$ V and $V_A = -3.0$ V respectively. What are the barrier heights for electron flows from S → M and M → S for each case now? Note that this junction will behave like a p^+-n rectifying junction.

2. Suppose for the above case, we used a metal with a work function of 4.0 eV. Now, draw the band diagram at equilibrium. Is the metal-semiconductor contact ohmic or rectifying? Explain.

3. Explain why MS diodes switch very rapidly from the forward bias "on state" to reverse bias "off state" (where as p-n diodes do not!).