

**ECSE-2210 Microelectronics Technology**  
**Homework 8**

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  $N_D = 10^{16} \text{ cm}^{-3}$ . 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  $q V_{\text{bi}}$  (where  $V_{\text{bi}}$  is called the built-in voltage) for electron flow from the semiconductor to metal ( $S \rightarrow M$ )? What is the barrier height ( $\Phi_B$ ) for electron flow from the metal to semiconductor ( $M \rightarrow S$ )? 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  $V_A = 0.1 \text{ V}$  and  $V_A = -3.0 \text{ V}$  respectively. What are the barrier heights for electron flows from  $S \rightarrow M$  and  $M \rightarrow S$  for each case now? Note that this junction will behave like a  $p^+ \text{-n}$  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!).