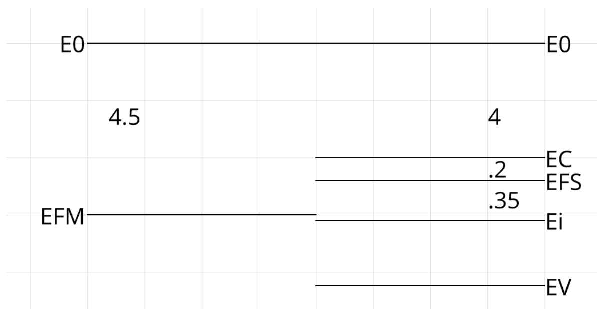
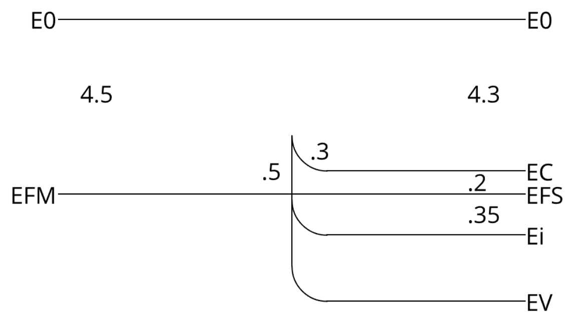
Hayden Fuller
Microelectronics HW9

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

1. 1. Assume that an ideal Schottky barrier is formed on n-type Si having ND = 1016 cm–3. The metal work function is 4.5 eV, and the Si electron affinity is 4.0 eV.
    a. (a) Draw equilibrium band diagrams such as in Fig 14.2 to scale. What is the barrier height q Vbi (where Vbi is called the built-in voltage) for electron flow from the semiconductor to metal (S → M)? What is the barrier height (ΦB) 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 E0 in the depletion layer?

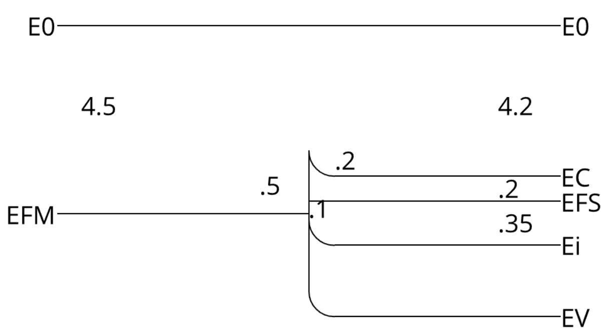




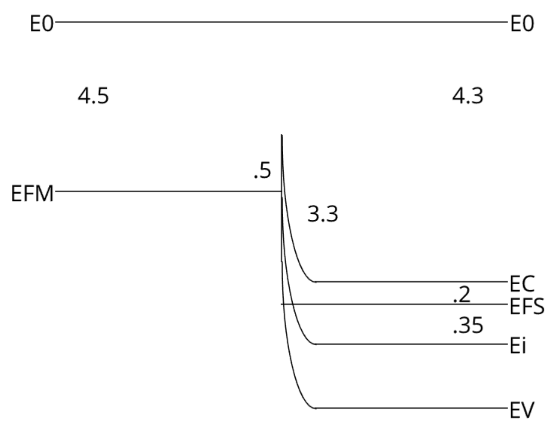
qVbi = S → M = 0.3eV
ΦB = M → S = 0.5eV
W = sqrt(2 epsilon Vbi / qND)=sqrt(2*11.8*8.85x10^-14*.3/(1.6x10^-19*10^16))=0.19um
E0 = q ND W/epsilon=2.9x10^4 V/cm

    b. (b) Draw to scale the forward- and reverse-bias band diagrams, as in Fig 14.3, for VA = 0.1 V and VA = –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.

0.1:

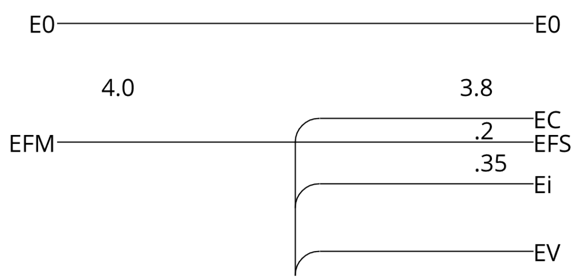


qVbi = S → M = 0.2eV
ΦB = M → S = 0.5eV
-3:



qVbi = S → M = 3.3eV
ΦB = M → S = 0.5eV

2. 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.



It's ohmic because there's no barrier for electrons to flow from S to M under equilibrium

3. 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!).

We don't have to deal with minority carriers and their lifetimes, allowing it to switch very quickly