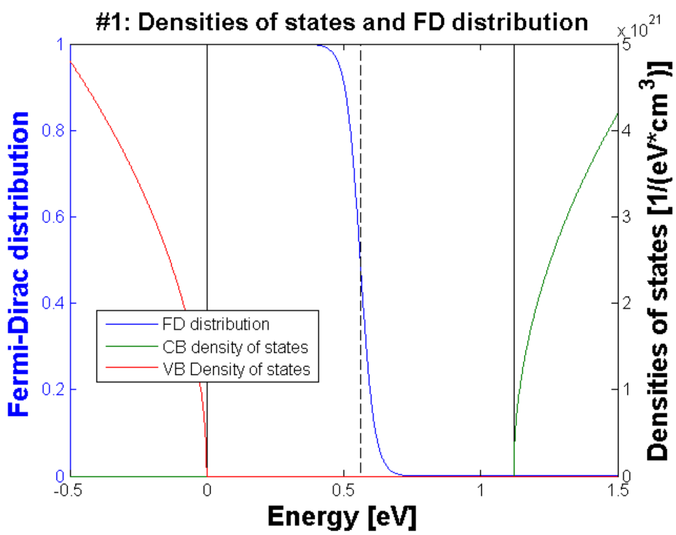
TN2624 MATLAB Session 11
Solutions

May 23, 2013

Semiconductor statistics Part 1 – the intrinsic semiconductor (70 pts)

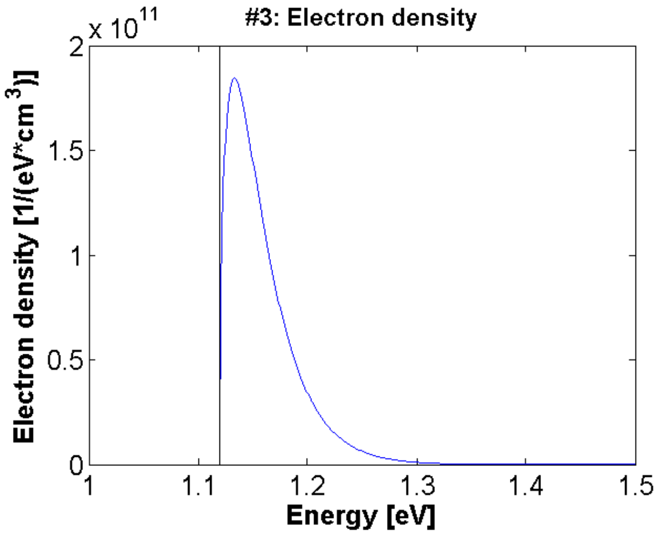
1. **(25 pts)** Fermi-Dirac distribution and density of states as a function of energy.



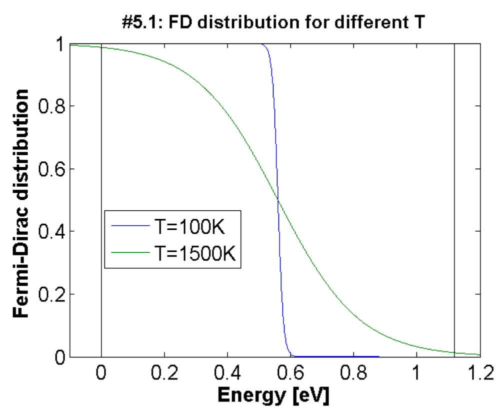
2. **(5 pts)** The same as the distribution for the electrons, but mirrored at the chemical potential

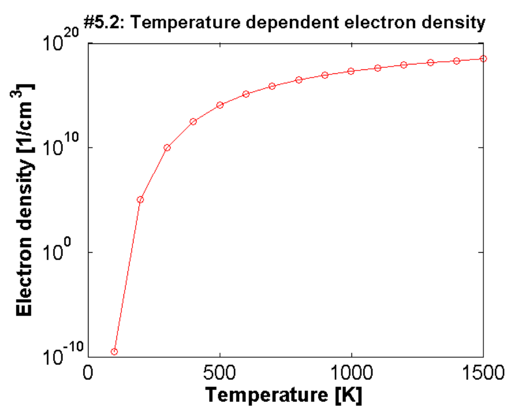
$$\bar{n}_{\mathrm{FD,h}}(E) = \frac{1}{1 + \exp\frac{\mu - E}{kT}}.$$

3. **(10 pts)**



4. **(5 pts)** `%Result: 9.8506e+09 1/cm^3`, way too low
5. **(25 pts)**

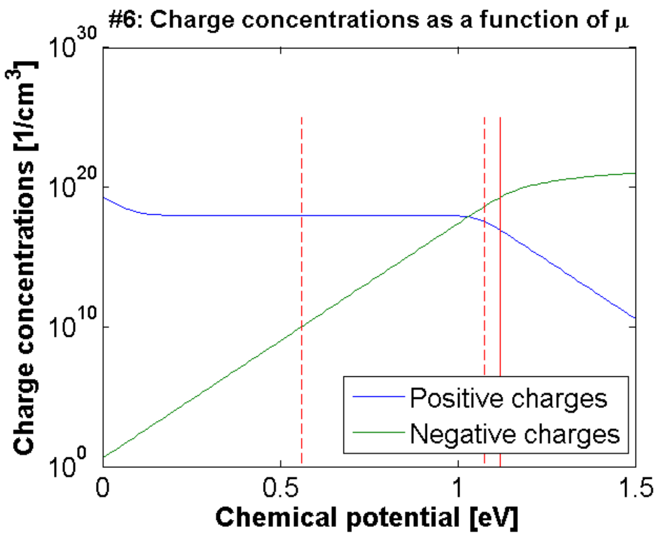




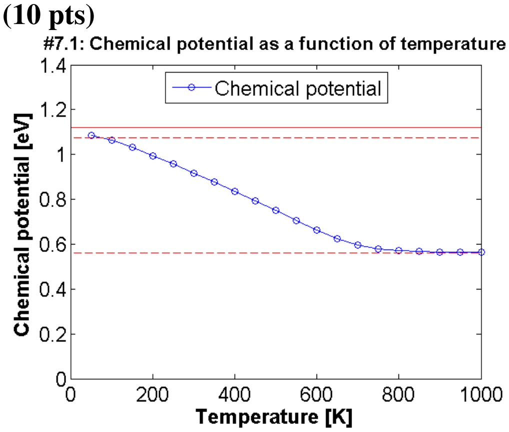
Fermi-Dirac distribution "smears out" at higher temperatures → more electrons excited to the conduction band
Unrealistically high temperatures would be required to obtain significant electron densities

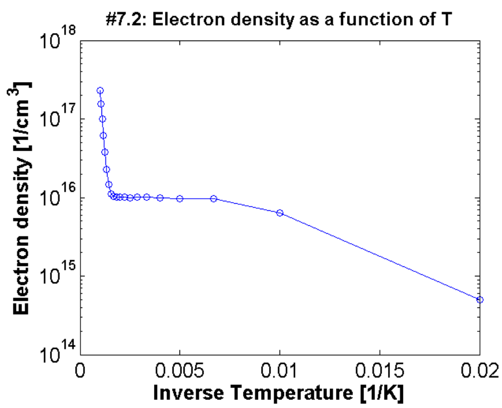
Semiconductor statistics Part 2 – the doped semiconductor (30 pts)

6. **(20 pts)**
`mu=1.0300 %eV`,
`n=7.6210e+17 %cm^-3`,
`p=125.9659 %cm^-3`, virtually no holes in the valence band... all electrons stem from the dopants



7. **(10 pts)**





- Low temperature: The electrons from the dopants get excited to the conduction band
- Medium temperature: All the dopants have been activated (electron density saturates to dopant density), yet the temperature is still too low to excite electrons from the valence band to the conduction band
- High temperature: Electrons can be excited from the valence band to the conduction band