ASSIGNMENT 7

Due: 19 November 2003

Problems: (See Tables 2-6 in Kittel, Chap. 8.)

1. (a) Measurements on a crystal of Ge yield the following values of resistance vs. temperature:

T(K)	310	321	339	360	383	405	434
R(Ω)	13.5	9.10	4.95	2.41	1.22	0.74	0.37

(a) Find the energy gap E_G after plotting the data.

(b) Donors (As) are added at a concentration of 0.0001%. Show that at 300 K essentially all of the donors are ionized.

(c) Calculate the change in the 300 K conductivity due to the added donors.

(d) Find the temperature at which the intrinsic conductivity equals that produced by the dopants. You can use a graphical solution.

2. Calculate the intrinsic conductivity of Si at 300 K. If 10^{20} cm^{-3} phosphorus atoms are added to the Si, what is the new carrier concentration? Find the position of the chemical potential. Hint: do not use a low-temperature approximation.

3. (a) Calculate the intrinisic conductivity of InSb at 300 K. (Use the heavy hole effective mass.)

If some Sb is replaced by Te calculate the following:

(b) ionization energy of the Te impurity

(c) radius of the weakest bound electron orbit on Te (in InSb)

(d) concentration of Te that leads to overlap of the Te orbits

(e) concentration of electrons and holes in (d) and position of the chemical potential.

4. A rectangular slab of a semiconductor has dimensions 10mm x 4 mm x 1 mm. A current I = 1.5 mA flows along the largest dimension with an associated potential difference of 78 mV. When a magnetic field B = 0.7 Wb m^{-2} is applied normal to the largest surface a potential difference of 6.8 mV appears across the width (4mm) of the semiconductor. Find the sign, concentration, and mobility of the charge carrier.