EMSE314--Fall 2003--Homework 5--Name: Changrong LI
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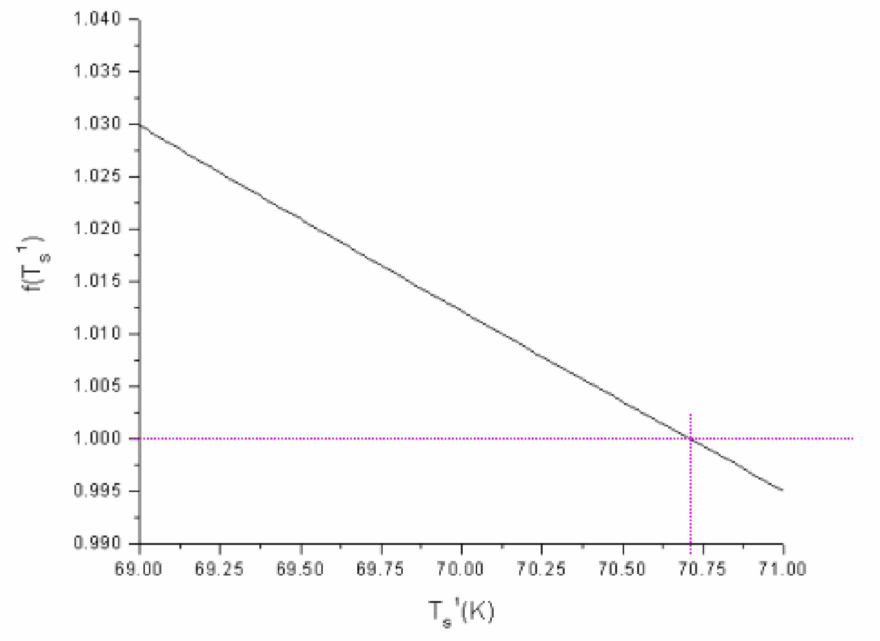
Problem 2— "temperature dependence of conductivity"

c) $N_c^{'} = 2(\frac{2\pi m_e^* k}{h^2}T)^{3/2} = 2.8\times10^{19}\times(\frac{T_s^{'}}{300})^{1.5} = (T_s^{'})^{1.5}\times5.389\times10^{15}\text{cm}^{-3}$

$$T_s^{'} = \frac{\Delta E}{k\ln\frac{N_c^{'}}{2N_d}} = \frac{0.045\times1.6\times10^{-19}}{1.38\times10^{-23}\times\ln\frac{(T_s^{'})^{1.5}\times5.389\times10^{15}}{2\times10^{15}}}.$$

Consider function $f(T_s^{'}) = \frac{1}{T_s^{'}}\times\frac{0.045\times1.6\times10^{-19}}{1.38\times10^{-23}\times\ln\frac{(T_s^{'})^{1.5}\times5.389\times10^{15}}{2\times10^{15}}} = \frac{1}{T_s^{'}}\times\frac{521.74}{[0.9912+1.5\ln T_s^{'}]}$

We can plot $f(T_s^{'})$ vs $T_s^{'}$ curve, as shown in the following diagram. The exact value of $T_s^{'}$ is given by $f(T_s^{'})=1$, i.e. $T_s^{'} = 70.70K$. The above solution will give +3 bonus points.



Problem 4—"thermal drift in semiconductor devices"

a) The potential of the cold side with respect to the hot side is taken as the sign of the Seebeck voltage and hence the Seebeck coefficient S. Thus, if electrons diffuse from hot to cold, then the Seebeck voltage (and hence S) is negative, and if holes diffuse from hot to cold then the Seebeck voltage is positive. The equation given in (b) only gives the magnitude of S.

This provides a convenient way to identify whether a semiconductor is doped *n*-type or *p*-type. If the hot side is positive with respect to the cold side then the semiconductor is *n*-type. If the hot side is negative then it is *p*-type. The simplest test is to touch the test leads of a voltmeter (1-10 mV range) to a semiconductor with one lead made hot. In reality, the semiconductor and the copper lead form a thermocouple but the Seebeck coefficient of the semiconductor is much greater than that of the metal lead.