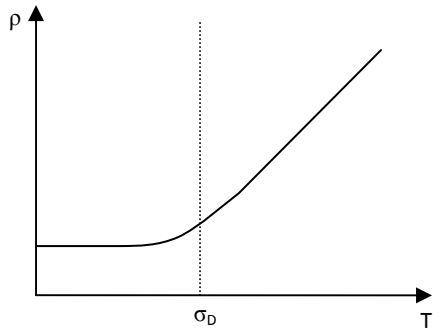
SEMICONDUCTOR PHYSICS **ECE 1336**

Problem Set #7: Free-Electron Theory of Metals

1. The figure below shows the typical relationship between resistivity (ρ) and temperature (T) for a metal. Qualitatively (no equations) describe this relationship and explain which physical process is most dominant in determining the resistivity for the followings regions:

(I) high temperature ($T >> \sigma_D$)

(ii) low temperature ($T << \sigma_D$)



2. Electrons in the conduction band of silicon have an effective mass of $0.259m_0$ and a mobility of $0.1350 m^2V^{-1}s^{-1}$ while holes in the valence band have an effective mass of $0.537m_0$ and a mobility of $0.0480 m^2V^{-1}s^{-1}$. Find the average relaxation time for (i) electrons and (ii) holes.

3. The electrical resistivity of a certain metallic sample is $1.77 \times 10^{-8}\ \Omega \cdot m$. Using the free electron approximation, estimate: (i) the relaxation time, and (ii) the average speed of electrons in a field of 100V/m. Note that atoms in the metallic sample form an FCC structure with a cube edge of 3.61A and each atom contributes one electron to a nearly free electron band. Assume $m^* = m_0$, where m_0 is the free electron mass.