ECE 656 Homework (Week 10)

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1) Show that the following relation (eqn. (4.119) in *Fundamentals of Carrier Transport*) is true:

$$e^{-\frac{\pi}{\rho_S}R_{MN,OP}} + e^{-\frac{\pi}{\rho_S}R_{NO,PM}} = 1$$

2) For n-type, bulk silicon doped at $N_D = 10^{17}$ cm^{-3} the room temperature mobility is 800 cm^2/V-s. Answer the following questions. Some potentially useful information is:

$N_C = 3.23\times10^{19}$ cm^{-3} $N_V = 1.83\times10^{19}$ cm^{-3} $E_G = 1.11$ eV $\upsilon_T = 1.05\times10^{7}$ cm/s.
Estimate the Seebeck coefficient. Make reasonable assumptions, but clearly state them.

3) A Hall effect experiment is performed on a n-type semiconductor with a length of 2.65 cm, a width of 1.70 cm, and a thickness of 0.0520 cm, in a magnetic field of 0.5 T. The current in the sample along its length is 200 mA. The potential difference along the length of the sample is 195 mV and across the width is 21.4 mV.

3a) What is the carrier concentration of the sample?
3b) What is the mobility?
3c) If the scattering time is 1ps, find the magnetic field for which this classical analysis of Hall effect is no longer valid?

4) Contact resistances are important. They can complicate measurements of semiconductor transport parameters, and they can degrade device performance. The constant resistance is specified by the interfacial contact resistivity, ρ_C, in $\Omega\text{-cm}^2$. A very good value is $\rho_C \approx 10^{-8}\Omega\text{-cm}^2$. Consider n$^+$ Si at room temperature and doped to $N_D = 10^{20}$ cm^{-3}. What is the lower limit to ρ_C? (Assume a fully degenerate semiconductor and use appropriate effective masses for the conduction band of Si.)