ECE 656: Fall 2009
Lecture 7 Homework SOLUTIONS

1) Work out the following sum for a ballistic, 1D resistor at T = 0K:

$$I^{+} = \frac{1}{L}\sum_{k>0} q v_x f_0(E_{F1})$$

2) Use the result from the corresponding sum over negative k-states,

$$I^{-} = \frac{1}{L}\sum_{k<0} q v_x f_0(E_{F2})$$

to show that for small bias, $qV = E_{F1} - E_{F2}$, the resulting current is

$$I - I^{+} - I^{-} = \frac{2q^2}{h}V$$

HW7 Solution

1) $I^+ = \frac{1}{L} \sum_{k>0} q v_x f_0(E_{F,1})$

$$= \frac{1}{L} \cdot \frac{L}{2\pi} \cdot 2 \int dk \, q \frac{dE}{d(\hbar k)} f_0(E_F)$$

$$= \frac{q}{\pi \hbar} \int_0^{E_{F1}} dE \, f_0(E_{F,1}) = \frac{q}{\pi \hbar} E_{F1}$$

2) $I^- = \frac{q}{\pi \hbar} E_{F2}$

$$I = I^+ - I^- = \frac{q}{\pi \hbar} (E_{F,1} - E_{F2}) = \frac{q^2}{\pi \hbar} \cdot V$$

$$\frac{q^2}{\pi \hbar} = \frac{q^2}{\pi h/2\pi} = \frac{2q^2}{h} \longrightarrow \boxed{I = \frac{2q^2}{h} V} \checkmark$$