Problem Set 6 - LV 141.246 QISS - 14.5.2012

1. **Coulomb Blockade at Room Temperature**

   Calculate the capacitance necessary to observe Coulomb blockade at room temperature.

   Assume a parallel plate capacitor with a spacing of 1 nm. What would be the plate area?

2. **Single Electron Transistor**

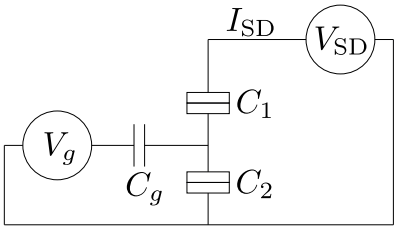

Figure 1: Single Electron Transistor

As calculated in the lecture, the Gibbs free energy for a single electron transistor is given by

$$G(V_{\mathrm{SD}}, V_g, n_1, n_2) = \frac{(ne - C_g V_g)^2}{2C_\Sigma} - \frac{n_1 C_1 + n_2(C_2 + C_g)}{C_\Sigma} eV_{\mathrm{SD}}$$

(a) Calculate the difference ΔG for a single electron tunneling through the upper junction $0 \to 1$

(b) Calculate the difference ΔG for this electron tunneling out through the lower junction $1 \to 0$

(c) At zero temperature, a current through the SET can flow if both ΔG are negative. Indicate in the V_{SD} vs V_g plane, where this condition is fulfilled.

(d) consider the reverse process: Tunneling through the lower junction $1 \leftarrow 0$ and then through the upper junction $0 \leftarrow 1$.

(e) consider other possible processes, like $1 \to 2 \to 1$, $-1 \to 0 \to -1$, $1 \leftarrow 2 \leftarrow 1$, etc.