Exercise 13

[1] (50pts) Two loop currents $C_1$ and $C_2$ are set as in the figure with the axis aligned. The distance between the centers are given by $z$. The radius of the loops are $a_1$ and $a_2$ respectively and $a_1 \gg a_2$. Estimate the mutual inductance $L_{12}$ and $L_{21}$. Demonstrate that $L_{12} = L_{21}$.

[2] (50pts) From Schwartz 5-4: A transmission line is made up of two long parallel perfect conductors of arbitrary cross section. Current flows down one conductor and returns on the other. The conductors are surrounded by vacuum. Show that the inductance per unit length $L$ and the capacitance per unit length $C$ are related by the equation $LC = 1$. [Hint: Make use of the Lorentz transformation to move with some velocity $v$ parallel to the conductors. Remember also that $L$ is measured in emu and $C$ is measure in esu. If $L$ is measure in esu then $L_{\text{esu}}C_{\text{esu}} = 1/c^2$. ]