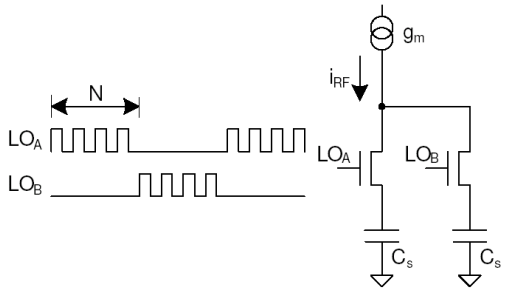
ECEN610: Mixed-Signal Interfaces

LAB 3: Analysis and Simulation of switched Gm-C Filters

1. Consider the following circuit, where N=8 and the frequency of the clocks is 2.4 GHz and Cs=15.925 pF. The capacitors are charged in a cyclic fashion by the input current i_{RF}. Similarly, the voltage stored in the capacitors Cs is read cyclically at the end of each consecutive N cycles. The output of the circuit is the concatenation of the cyclic readings of the voltages. Consider the following 2 cases:

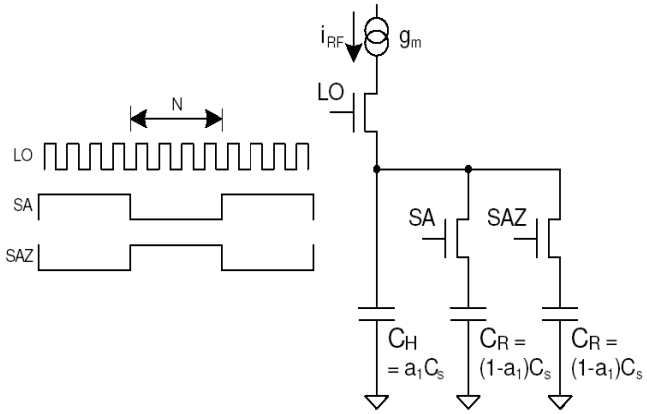
a) The capacitors are discharged after each read out operation, i.e. the charge of the capacitors is zero at the beginning of the integration of every N cycles.
b) The capacitors are never discharged.

In both cases find the filter transfer function $H(f)=Vo(f)/i_{RF}(f)$ where Vo(f) is the capacitor voltage. Please use a mathematical description of how the transfer function is found and then use Python to plot the transfer functions.



2. Now consider the addition of a "history" capacitor $C_{H=}$15.425 pF and a "rotating" capacitor C_R=0.5 pF.

a.) Explain the effect of adding the capacitor C_H in the transfer function that was calculated in problem 1.
b.) Find the new transfer function and plot it using Python.



3. Consider the following circuit. This is just an extension of the previous circuit where the cyclic operation is extended to 8 capacitors. As in the previous circuit, every capacitor also stores N=8 cycles of the input switched current. The output voltage is defined as the voltage resulting from the physical connection of the bank of 4 capacitors enclosed by the rectangle in the figure. This read out operation is also made in a cyclic fashion between the 2 bank of capacitors. Assume ideal transistors and an ideal transconductance gm. Find a mathematical expression for the transfer function and plot in Python for the following 2 situations.

a) The 4 capacitors are discharged after their connection and read out operation, i.e. the charge of the capacitors is zero at the beginning of the integration of every N cycles.
b) The capacitors are never discharged.
c) The capacitors are discharged but they have different sizes, i.e. CR1, CR2, CR3, CR4.