EE240C: Analog-Digital Interface Integrated Circuits **2019**

Homework #3

(due Mon 10/14/2019; submit through bCourses)

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The goal of homework 3 is to verify your circuit simulation setup; we'll use the Cadence Generic 45nm PDK for circuit simulations. Most of the netlist will be provided for this homework.

The following instructional machines are available for simulations (shared with other classes):

- `eda-1.eecs.berkeley.edu` through `eda-8.eecs.berkeley.edu`
- `hpse-9.eecs.berkeley.edu` through `hpse-15.eecs.berkeley.edu`

If you have access to a comparable technology for research purposes, you are free to use that technology.

Two additional files are provided with this homework:

- `setup.sh`: a shell script that setups the paths for you to run Cadence on the instructional machines, including the Cadence MATLAB toolbox.
- `problem.scs`: an initial netlist.

Problem 1. Switch simulation

Shown below in figure 1 is the schematic of a CMOS sampling switch in its "ON" state (assuming $\Phi = V_{DD}$).

a) Run the unmodified netlist by issuing `spectre problem.scs` after sourcing the setup script (`source setup.sh`). Verify that `spectre` finishes without errors.

b) Adjust the netlist to run a DC sweep and plot the on-resistance of the NMOS transistor MN, the PMOS transistor PM, and the parallel resistance MN||PM. The provided Spectre deck will save all the operating point parameters during DC sweeps once a `dc` statement is added.

Hint: use `spectre -help dc` to figure out the dc sweep parameters

Hint: the model files use BSIM4 models, which have a `gds` operating point parameter

Hint: the MATLAB function `cds_srr` can be used to access the Cadence result values from MATLAB: if the results are in '`problem.raw`', then

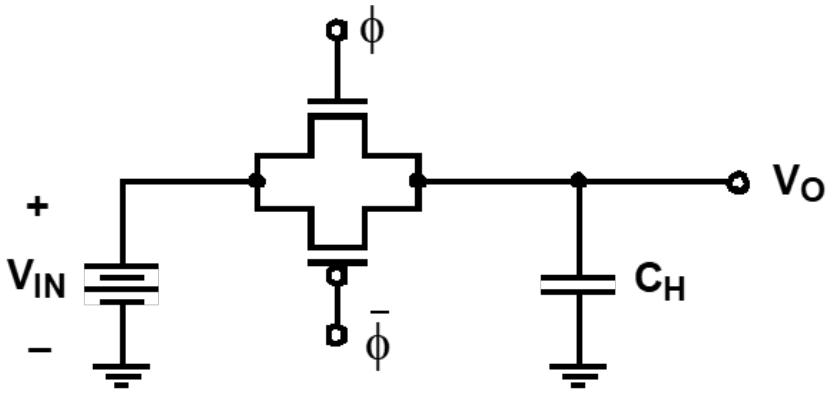

Figure 1: CMOS sampling switch

`cds_srr('problem.raw', 'dc-dc', 'm1:gds')` will return a structure with data for the particular simulation result; it is also possible to use the Cadence waveform viewer ViVA (command-line command `viva`).

c) For the transient simulations that will be run in part d, the frequency is set indirectly by the netlist parameter `NUM_PERIODS`, with a value equal to 511. Why is the frequency specified as a number of periods, and why is the value 511 (instead of e.g. 512) ?

d) Uncomment one of the transient analysis statements, and determine HD3 for `NUM_PERIODS` = 511, 127, 63, and 31; plot HD3 as a function of the signal frequency. Use the last 16384 samples of the simulation, ignoring the initial stabilization period.

Option 1: run the single transient (`tran_single`) once for each of the value of the parameter `NUM_PERIODS`.

Option 2: run the swept transient and extract all information from one simulation run.