



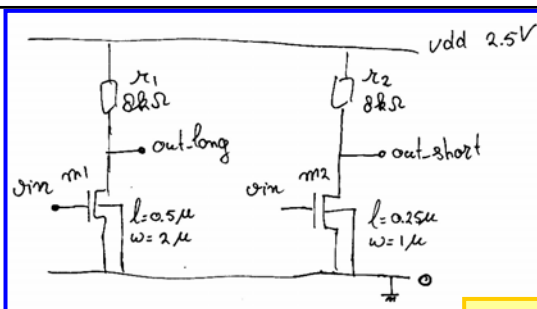
Spectre / Lab Intro

Lab / Project

- Prepare yourself, form **pairs**
- Become familiar with linux, cadence
- Can use computers in MSc lab (16th floor)
- Instructions are posted on web, being augmented through the course
- Need a **login**:
 - One login account for a team
 - Visit **Antoon Frehe**, room 17.070,
a.frehe@EWI.TUdelft.NL, 081796

This Week's Plan

1. Become familiar with linux
 - Tutorial: <http://www.ee.surrey.ac.uk/Teaching/Unix/>
 - In general, resources on class website
 - Use (!) **BB forum** to ask questions and share knowledge
2. Become familiar with Spectre (ckt sim)
 - Next slides show how to solve Rabaey Exercise 3.11
3. Use Spectre for Rabaey Exercises 3.4 and 3.5
 - Spectre instructions follow
 - Hand-in 1 A4 with 4 annotated graphs on Mon 18/2 before class
 - Write you names (as a team) on it
 - Will not be graded, I will provide feedback if necessary



Simulation Example

- Make sketch
- Assign node names
- Write file
- Add control statements

Exercise 3.11

```

simulator lang=spectre
include "g25_scs.lib"
vdd (vdd 0) vsource dc=2.5
vin (in 0) vsource dc=2.5
r1 (vdd out_long) resistor r=8K
r2 (vdd out_short) resistor r=8k
m1 (out_long in 0 0) nmos l=0.5u w=2u
m2 (out_short in 0 0) nmos l=0.25u w=1u
Inputsweep dc param=dc dev=vin start=0 stop=2.5 step=0.1
save vin out_long out_short
    
```

250nm Spectre BSIM3 MOS Models

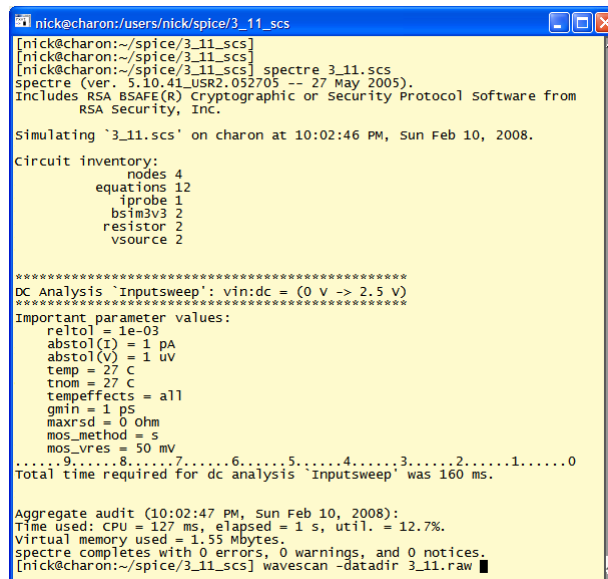
```

simulator lang=spectre
model nmos bsim3v3
+version=3.1
+type=n
+tnom    = 25          xl      = 3e-8
+XW      = 0           tox     = 5.8e-9
+Xj      = 1e-07        nch    = 2.354946e+17  lln    = 1
+vth0   = 0.4321336   lvth1  = 2.081814e-08  wvth0  = -5.470342e-11
+pvth0   = -6.721795e-16 k1    = 0.3281252    lk1    = 9.238362e-08
... 60 lines deleted ...
+tleve   = 1           tlevc   = 1           js    = 1e-06
+jsw     = 5e-11

```

- Similar for **pmos** device

Spectre Terminal Interface



```

nick@charon:~/spice/3_11_scs
nick@charon:~/spice/3_11_scs
nick@charon:~/spice/3_11_scs$ spectre 3_11.scs
Spectre (Ver. 5.10.41 USR2.052705 -- 27 May 2005).
Includes RSA BSAFE(R) Cryptographic or Security Protocol Software from
RSA Security, Inc.

Simulating '3_11.scs' on charon at 10:02:46 PM, Sun Feb 10, 2008.

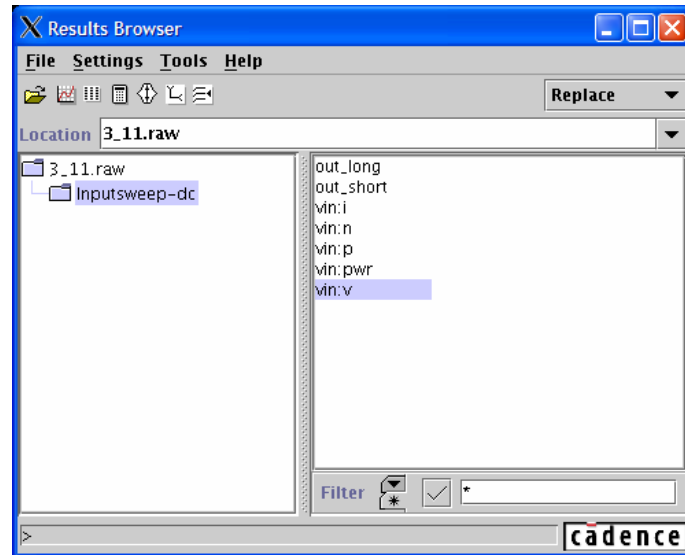
Circuit inventory:
  nodes 4
  equations 12
  iprobe 1
  bsim3v3 2
  resistor 2
  vsource 2

*****
DC Analysis 'Inputsweep': vin:dc = (0 V -> 2.5 V)
*****
Important parameter values:
  reltol = 1e-03
  abstol(I) = 1 pA
  abstol(V) = 1 uV
  temp = 27 C
  tnom = 27 C
  tempeffects = all
  gmin = 1 pS
  maxrsd = 0.0hm
  mos_method = s
  mos_vres = 50 mV
.....9.....8.....7.....6.....5.....4.....3.....2.....1.....0
Total time required for dc analysis 'Inputsweep' was 160 ms.

Aggregate audit (10:02:47 PM, Sun Feb 10, 2008):
Time used: CPU = 127 ms, elapsed = 1 s, util. = 12.7%.
Virtual memory used = 1.55 Mbytes.
Spectre completes with 0 errors, 0 warnings, and 0 notices.
nick@charon:~/spice/3_11_scs$ wavescan -datadir 3_11.raw

```

WaveScan Results Browser

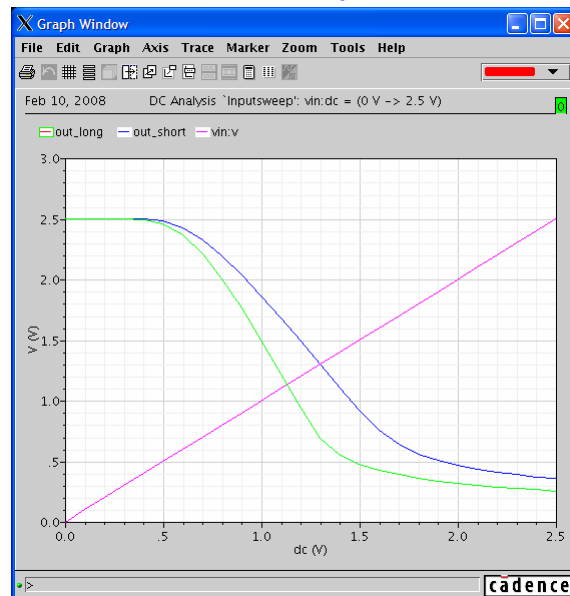


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WaveScan Graph Window



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Exercise 4+5

4. [E, SPICE, 3.3.2] Using SPICE plot the I - V characteristics for the following devices.

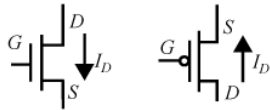


Figure 0.3 NMOS and PMOS devices.

- a. NMOS $W = 1.2\mu\text{m}$, $L = 0.25\mu\text{m}$
 - b. NMOS $W = 4.8\mu\text{m}$, $L = 0.5\mu\text{m}$
 - c. PMOS $W = 1.2\mu\text{m}$, $L = 0.25\mu\text{m}$
 - d. PMOS $W = 4.8\mu\text{m}$, $L = 0.5\mu\text{m}$
5. [E, SPICE, 3.3.2] Indicate on the plots from problem 4.
- a. the regions of operation.
 - b. the effects of channel length modulation.
 - c. Which of the devices are in velocity saturation? Explain how this can be observed on the I - V plots.

Tips

- Make 4 circuits, 1 for each of the cases 4a-4b
- Each circuit will have 6 transistors
 - All drains are connected, drain voltage to be swept from 0 to 2.5 V
 - All gates unconnected, different gate voltages: 0, 0.5, 1.0, 1.5, 2.0, 2.5 V
- Plot each circuit in a separate graph, combine them on 1 page (word or latex)
 - Wavescan can export png files, looks better compared to screen dumps

TA Help

- Help will be available in MSc lab
- Schedule to be determined, options are:
 - Tuesday afternoon
 - Friday morning
 - Friday afternoon
 - ...
- **BB Forum** – me and TA's will answer questions