PSPICE

What is Spice?

- Spice is the short form of:
  - **S**imulated
  - **P**rogram with
  - **I**ntegrated
  - **C**ircuit
  - **E**mphasis

PSPICE Programming

- Why PSPICE Programming
- Steps of Programming
- Statements
- Data Statements
- Control Statements
- Example Circuits

Why PSPICE Programming

- Don’t have to draw the circuit
- More control over the parts
- More control over the analysis
- Don’t have to search for parts
- Some SPICE software (HSPICE etc.) don’t have GUI at all
- Quick and efficient

Steps of Programming

- Draw the circuit and label the nodes
- Create net list (*.cir) file
- Add in control statements
- Add in title, comment & end statements
- Run PSPICE
- Evaluate the results of the output

Statements

- **Different statements:**
  - Not case sensitive
  - **title** - first line of code or keep Blank (always)
  - .**end** - last line of code (always)
  - Comment: line denoted by *
  - Data: resistor, capacitor, etc.
  - Control: analysis and output

Data Statements

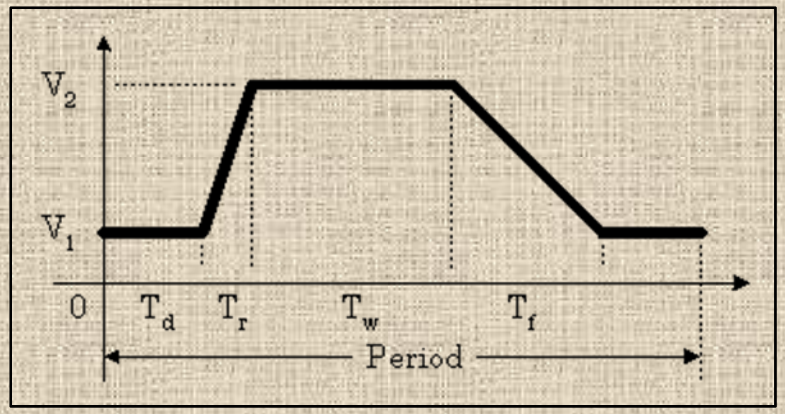
- **Resistor**
  - **R**<name><node1><node2><value>
  - Example: R1 1 2 100
- **Capacitor**
  - **C**<name><node1><node2><value>
  - Example: C1 13 0 1u
- **Inductor**
  - **L**<name><node1><node2><value>
  - Example: L1 5 4 1m

Data Statements

- **Independent Voltage Source**
  - **V**<name><+ node><- node> [[DC] <value>] [AC <magnitude> [phase]] [transient + specification]
- **3 types of sources**:
  - **DC**: Vin 1 0 5
  - **AC**: Va 4 0 AC 25
  - **Transient**

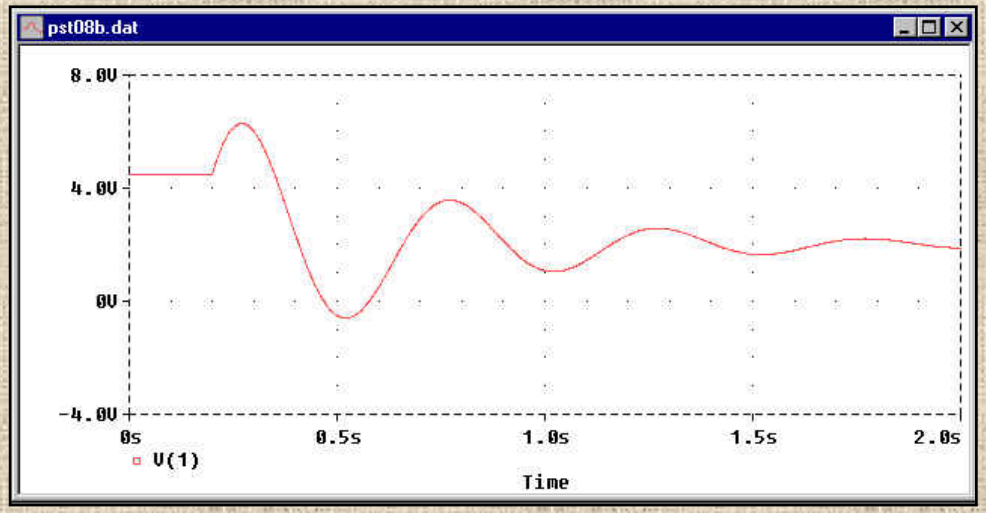
Data Statements

- **Transient Source**
  - vname <n+><n-> pulse(V1 V2 Td Tr Tf Tw Period)
  - Example 1: va 2 0 pulse(5 0 0 1p 1p 10n 20n)
  - Example 2: vb 3 0 pulse(5 0 0 1p 1p 5n 10n)



Data Statements

- **Transient Source**
  - vname <n+> <n-> sin(Vo Va freq td phase)
  - vname <n+> <n-> pwl(t1,v1,t2,v2,…,tn,vn)



Data Statements

- **Independent Current Source**
  - **I**<name><+ node><- node> [[DC] <value>][AC <magnitude> [phase]]
    [transient + specification]
- Same as Independent Voltage Source

Data Statements

- **MOSFET**
  - **m**<name><drain><gate><source><substrate><model>[W=<value>][L=<value>]
  - **.model** <name><NMOS or PMOS>[params]
- Example:
  - mp1 4 2 1 1 ptype w=5u l=2.5u
  - mn1 5 2 0 0 ntype w=5u l=5u
  - .model ptype PMOS(VTO=-1V KP=15u)
  - .model ntype NMOS(VTO=1V KP=30u)

Data Statements

- **Suffixes**

f	femto	10^{-15}
p	pico	10^{-12}
n	nano	10^{-9}
u	micro	10^{-6}
m	milli	10^{-3}
k	kilo	10^{3}
meg	mega	10^{6}
g	giga	10^{9}
t	tera	10^{12}

Control Statements

- **Analysis Types**
  - DC Analysis: **.dc**
  - AC Analysis: **.ac**
  - Transient Analysis: **.tran**
- **Output Format**
  - Text Output: **.print, .plot**
  - Graph Output: **.probe**

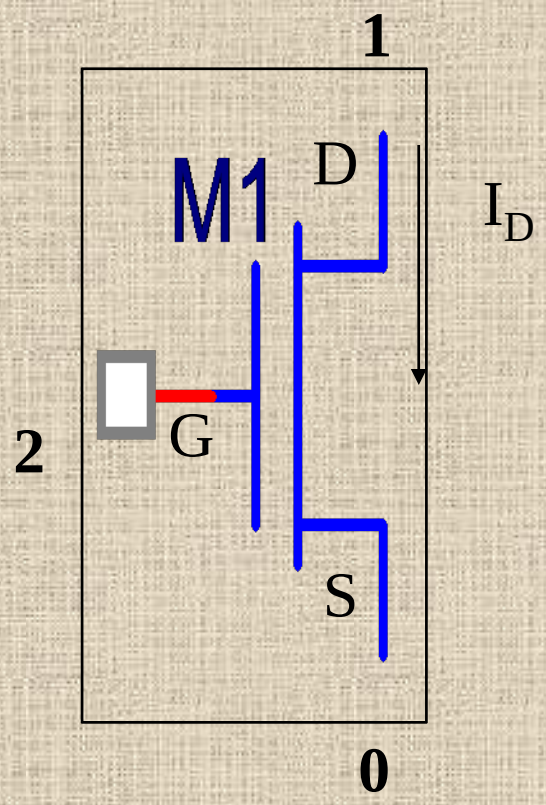
DC Analysis

- **Format**
  - **.dc** <source> <vstart> <vstop> <vincr> [src2 start2 stop2 incr2]
- Example:
  - .dc Vin 0.25 5.0 0.25
  - .dc Vds 0 10 0.5 Vgs 0 5 1

DC Analysis

Plot I-V Characteristics of NMOS

```
m1 1 2 0 0 ntype
.model ntype NMOS(vto=1 kp=30u)
vgs 2 0 5
vds 1 0 5
.probe
.print dc i(vds)
.dc vds 0 5 .5 vgs 0 5 1
.end
```



cir1 - OrCAD PSpice A/D - [cir1.cir (active)]

File Edit View Simulation Trace Plot Tools Window Help

cir1

```
MOSFET I-V Characteristics

M1 1 2 0 0 NTYPE
.MODEL NTYPE NMOS(VTO=1 KP=30u)
Vgs 2 0 5
Vds 1 0 5
.PROBE
.PRINT DC I(Vds)
.DC Vds 0 5 .5 Vgs 0 5 1
.END
```

cir1.cir (active) | cir1.dat (act... | cir1.out (act...

```
---------- Simulation Circuit File: cir1 ----------
Simulation running...
MOSFET I-V Characteristics
Reading and checking circuit
Circuit read in and checked, no errors
DC Analysis
DC Analysis finished
Simulation complete
```

MosFETs:	1
Voltage Sources:	2

Analysis | Watch | Devices

Start | Yahoo!... | 1st Tut... | Yahoo!... | PSPICE | PSPIC... | Foxit P... | Yahoo!... | PSPIC... | slides.ppt | cir1 - ... | 1:37 AM

cir1 - OrCAD PSpice A/D - [cir1.out (active)]

File Edit View Simulation Trace Plot Tools Window Help

cir1

```
MOSFET I-V Characteristics


****     DC TRANSFER CURVES                TEMPERATURE =   27.000 DEG C


******************************************************************************


 Vds          I(Vds)

  0.000E+00   0.000E+00
  5.000E-01  -5.100E-13
  1.000E+00  -1.010E-12
  1.500E+00  -1.510E-12
  2.000E+00  -2.010E-12
  2.500E+00  -2.510E-12
  3.000E+00  -3.010E-12
  3.500E+00  -3.510E-12
  4.000E+00  -4.010E-12
  4.500E+00  -4.510E-12
  5.000E+00  -5.010E-12
  0.000E+00   0.000E+00
  5.000E-01  -5.100E-13
  1.000E+00  -1.010E-12
  1.500E+00  -1.510E-12
  2.000E+00  -2.010E-12
  2.500E+00  -2.510E-12
```

cir1.cir (act... cir1.dat (act... cir1.out (act...

---------- Simulation Circuit File: cir1 ----------
Simulation running...
MOSFET I-V Characteristics
Reading and checking circuit
Circuit read in and checked, no errors
DC Analysis
DC Analysis finished
Simulation complete

MosFETs:	1
Voltage Sources:	2

Analysis Watch Devices

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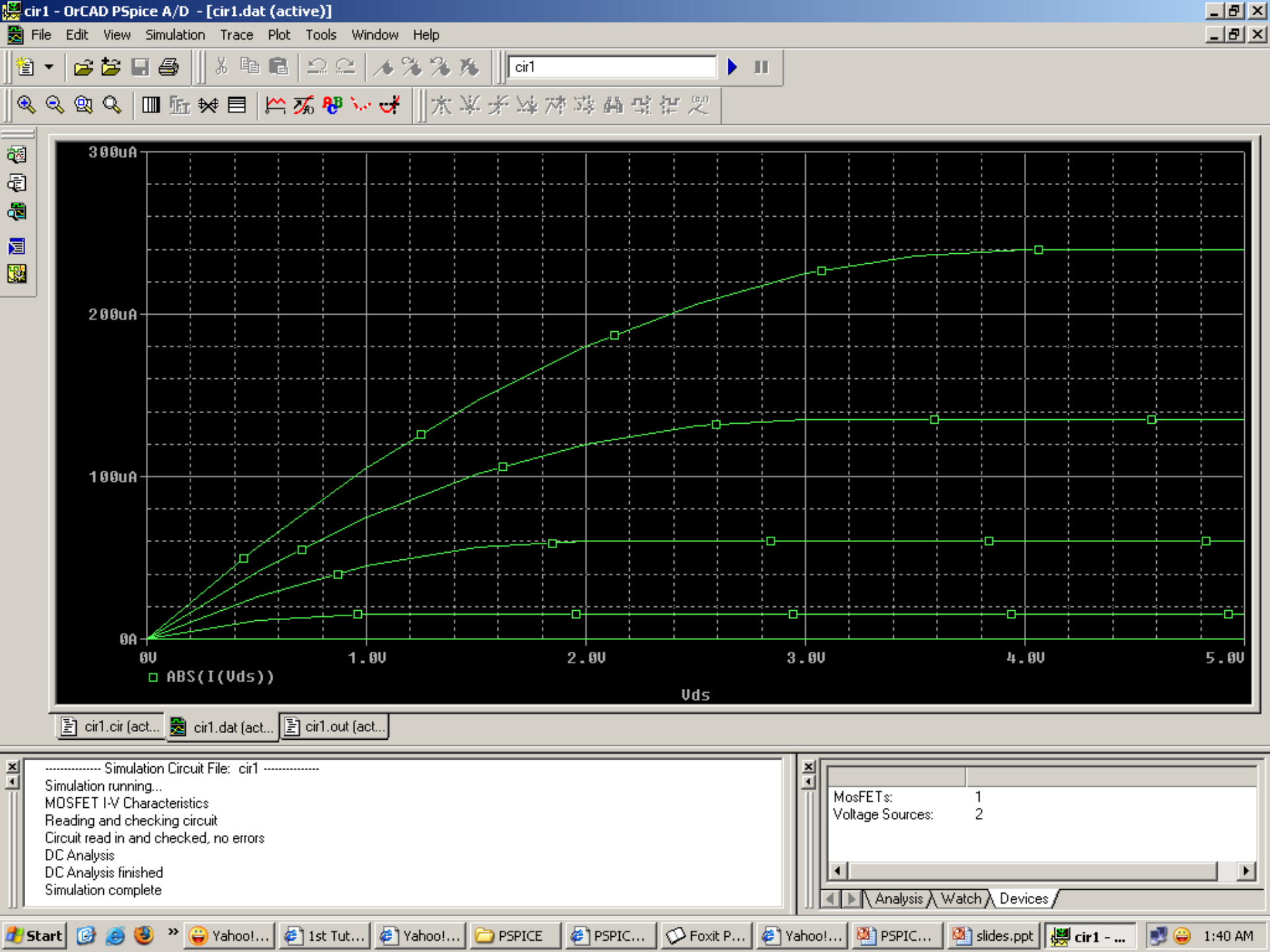

cir1 - OrCAD PSpice A/D - [cir1.dat (active)]
File Edit View Simulation Trace Plot Tools Window Help
cir1
300uA
200uA
100uA
0A
0V
1.0V
2.0V
3.0V
4.0V
5.0V
ABS(I(Vds))
Vds
cir1.cir (act...
cir1.dat (act...
cir1.out (act...
---------- Simulation Circuit File: cir1 ----------
Simulation running...
MOSFET I-V Characteristics
Reading and checking circuit
Circuit read in and checked, no errors
DC Analysis
DC Analysis finished
Simulation complete
MosFETs: 1
Voltage Sources: 2
Analysis
Watch
Devices
Start
Yahoo!...
1st Tut...
Yahoo!...
PSPICE
PSPIC...
Foxit P...
Yahoo!...
PSPIC...
slides.ppt
cir1 - ...
1:40 AM

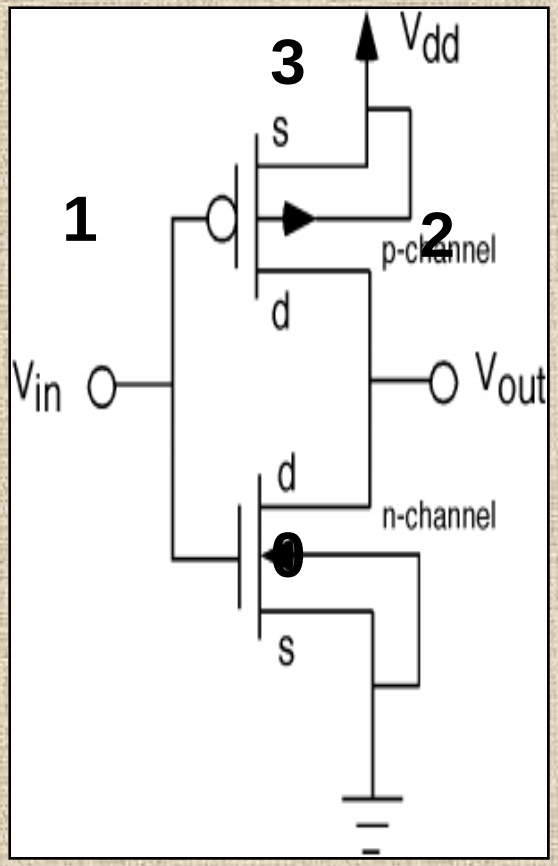
Transient Analysis

- **Format**
  - **.tran** <print step><final time>
- Example
  - .tran 1n 1000n

Transient Analysis

CMOS Inverter

vin 1 0 pulse(0 5 0 1p 1p 5n 10n)
vdd 3 0 5
m2 2 1 3 3 ptype w=5u l=2.5u
m1 2 1 0 0 ntype w=5u l=5u
.model ptype PMOS(kp=15u vto=-1)
.model ntype NMOS(kp=30u vto=1)
.probe
.tran 1n 20n
.end



cir4 - OrCAD PSpice A/D - [cir4.cir (active)]

File Edit View Simulation Trace Plot Tools Window Help

cir4

```
CMOS Inverter

Vin 1 0 pulse(0 5 0 1p 1p 5n 10n)
Vdd 3 0 5
M2 2 1 3 3 PTYPE W=5u L=2.5u
M1 2 1 0 0 NTYPE W=5u L=5u

.MODEL PTYPE PMOS(KP=15u VTO=1)
.MODEL NTYPE NMOS(KP=30u VTO=1)

.PROBE
.TRAN 1n 20n
.END
```

cir4.cir (active) cir4.dat (act...

```
CMOS Inverter
Reading and checking circuit
Circuit read in and checked, no errors
Calculating bias point for Transient Analysis
Bias point calculated
Transient Analysis
Transient Analysis finished
Simulation complete
```

MosFETs:	2
Voltage Sources:	2

Analysis Watch Devices

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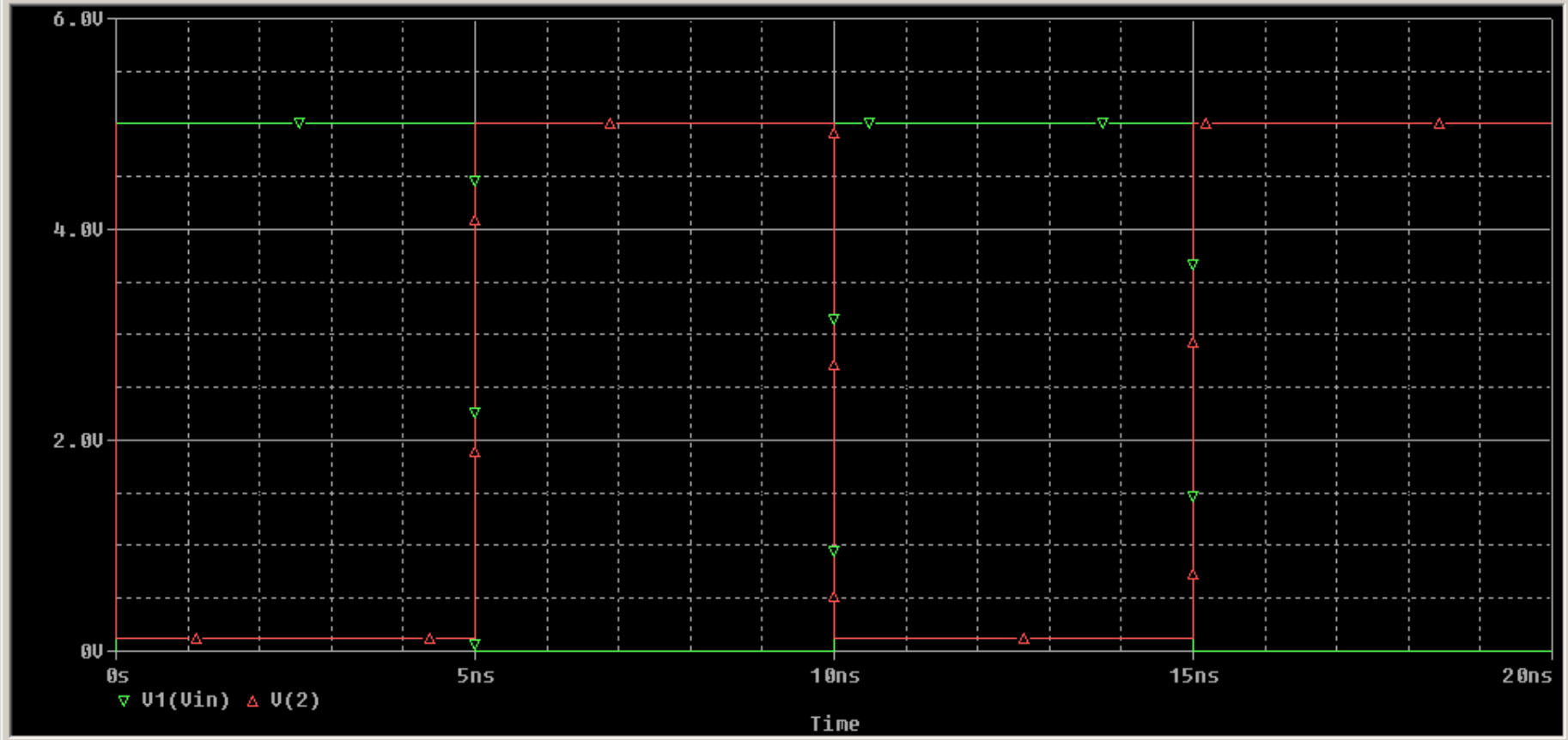
cir4 - OrCAD PSpice A/D - [cir4.dat (active)]

File Edit View Simulation Trace Plot Tools Window Help

cir4



cir4.cir (act... cir4.dat (act...

CMOS Inverter
Reading and checking circuit
Circuit read in and checked, no errors
Calculating bias point for Transient Analysis
Bias point calculated
Transient Analysis
Transient Analysis finished
Simulation complete

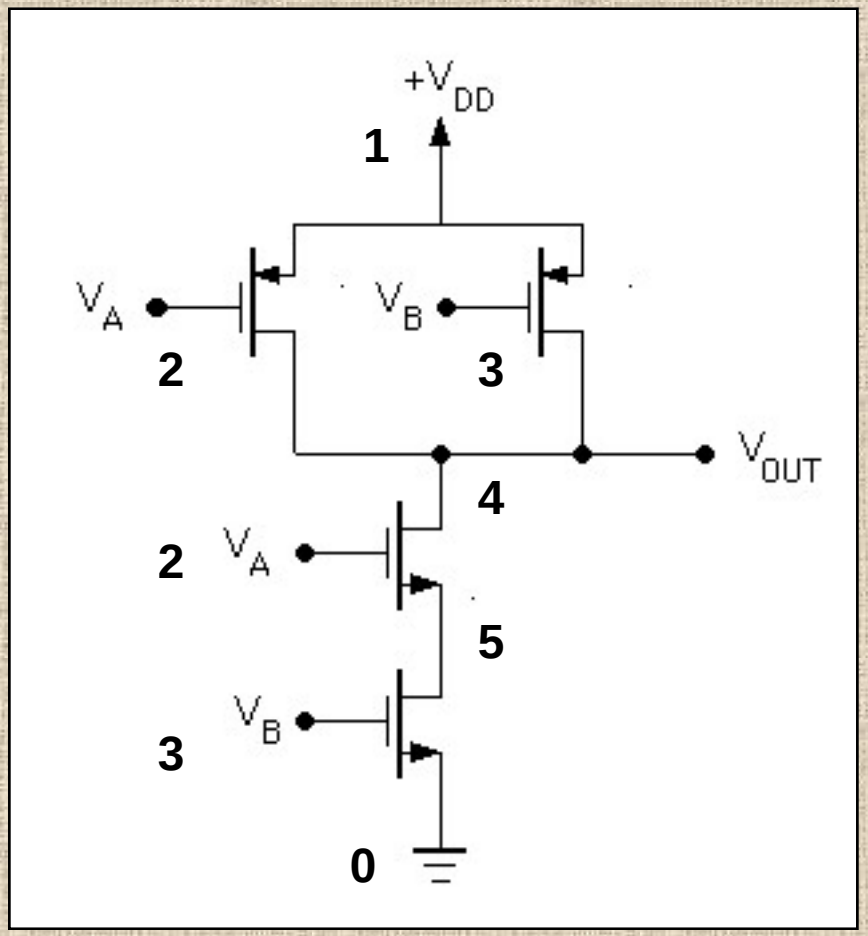
MosFETs:	2
Voltage Sources:	2

Analysis Watch Devices

Start Yahoo!... Yahoo!... PSPICE PSPIC... Foxit P... Yahoo!... PSPIC... slides.ppt cir4 - ... CMOS ... 3:02 AM

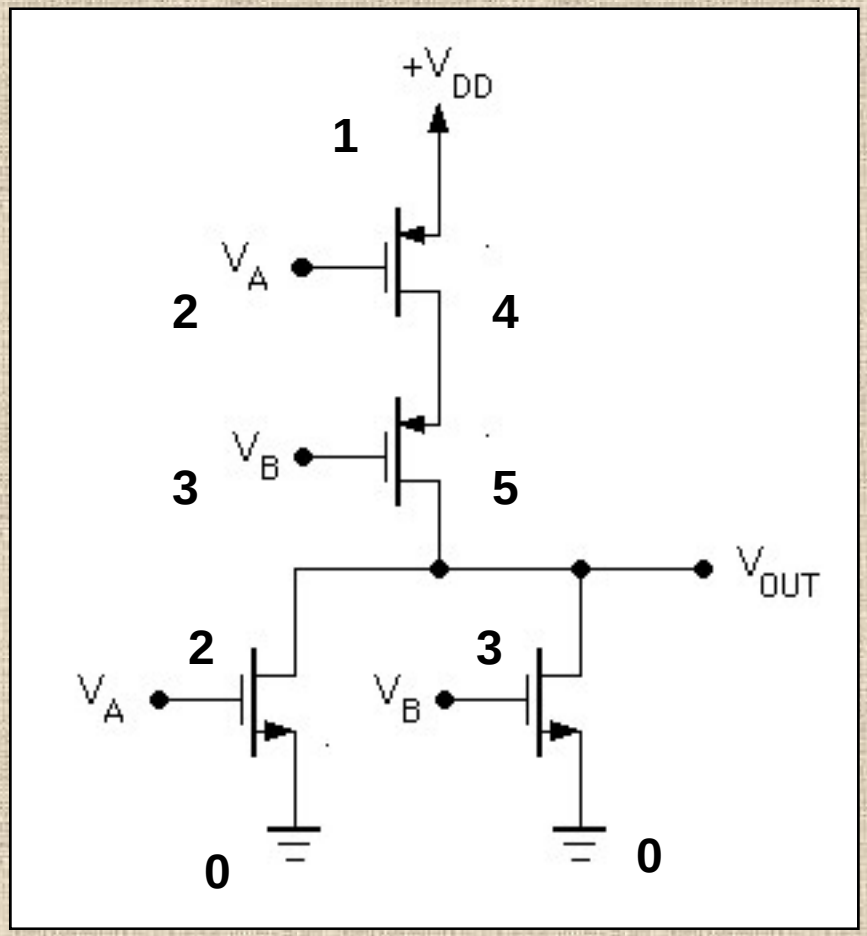
CMOS NAND

```
mp1 4 2 1 1 p w=5u l=2.5u
mp2 4 3 1 1 p w=5u l=2.5u
mn1 4 2 5 0 n w=5u l=5u
mn2 5 3 0 0 n w=5u l=5u
.model p PMOS(VTO=-1 KP=15u)
.model n NMOS(VTO=1 KP=30u)
vin1 2 0 pulse(0 5 0 1n 1n 5u 10u)
vin2 3 0 pulse(0 5 2.5u 1n 1n 5u 10u)
vp 1 0 5
.probe
.tran 0 30u .1u
.end
```



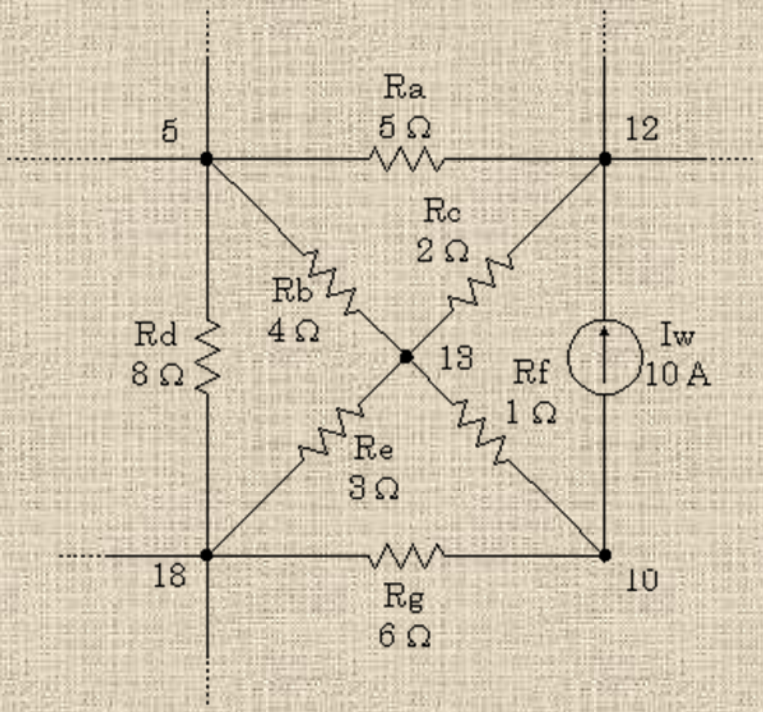
CMOS NOR

```
mp1 4 2 1 1 p w=5u l=2.5u
mp2 5 3 4 1 p w=5u l=2.5u
mn1 5 2 0 0 n w=5u l=5u
mn2 5 3 0 0 n w=5u l=5u
.model p PMOS(VTO=-1 KP=15u)
.model n NMOS(VTO=1 KP=30u)
vin1 2 0 pulse(0 5 0 1n 1n 5u 10u)
vin2 3 0 pulse(0 5 2.5u 1n 1n 5u 10u)
vp 1 0 5
.probe
.tran 0 30u .1u
.end
```



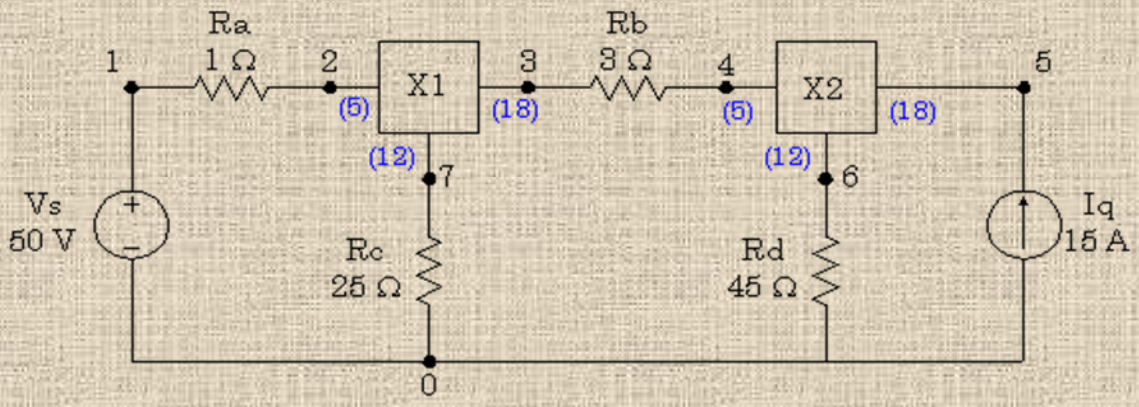
Sub Circuit

```
.subckt sub1  5   12   18
Iw   10   12   10A
Ra    5   12   5.0
Rb    5   13   4.0
Rc   12   13   2.0
Rd    5   18   8.0
Re   13   18   3.0
Rf   10   13   1.0
Rg   10   18   6.0
.ends
```



Sub Circuit

```
.include sub1.cir
Vs1  0  50
Iq   5  0  15
Ra      1  2  1
Rb      3  4  3
Rc7  0  25
Rd      6  0  45
X1      2  7  3   sub1
X2      4  6  5   sub1
.end
```



Thanks