EE671 : VLSI Design
Assignment 1 Report Submission
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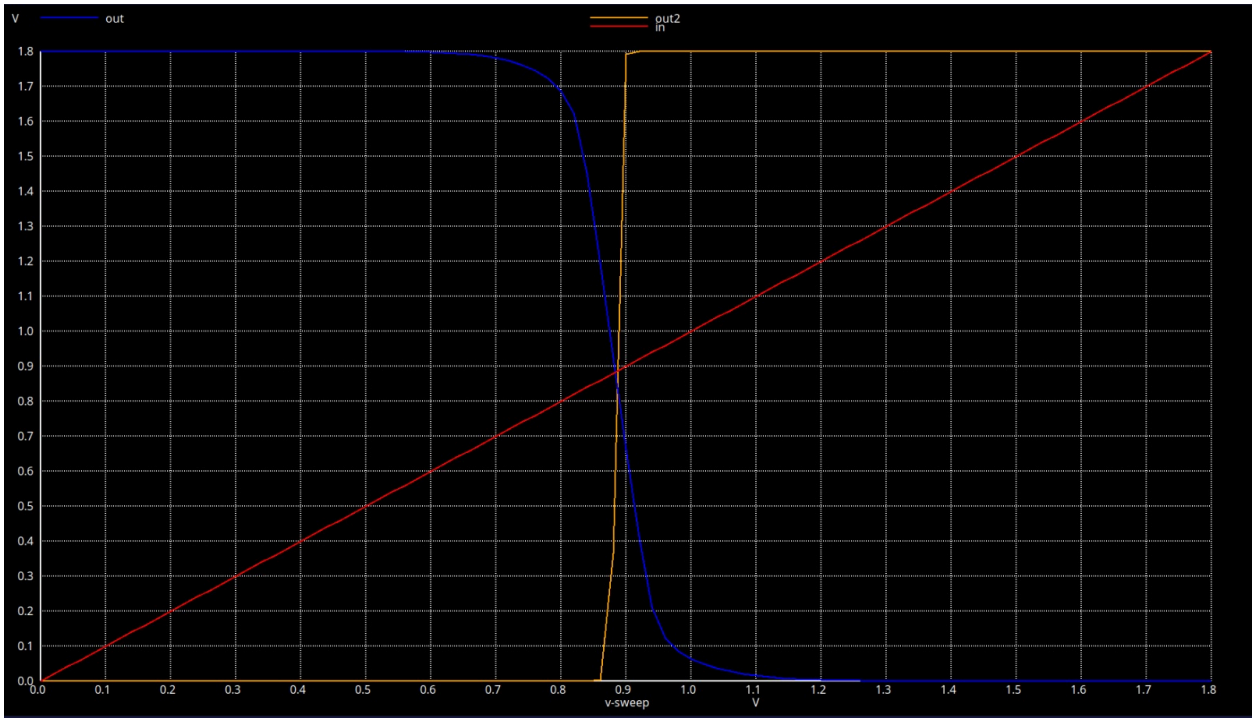
Q1. Design of INVX-1 inverter (loaded with INVX1 inverter)

Inverter Design Parameter	Value
PMOS Width (µm)	1.25
PMOS Length (µm)	0.15
NMOS Width (µm)	0.4
NMOS Length (µm)	0.15

Inverter Dynamic Characteristics	Value
Rise Time (ps)	19
Fall Time (ps)	19
Propagation Delay (ps)	13.5

Inverter Static Characteristics	Value
VIH (V)	0.988
VIL (V)	0.754
NMH (V)	0.812
NML (V)	0.754
Switching Voltage, VM (V)	0.895



Plot of DC sweep input from 0V to 1.8V
Plot contains input voltage, output of inverter, and output of load inverter.

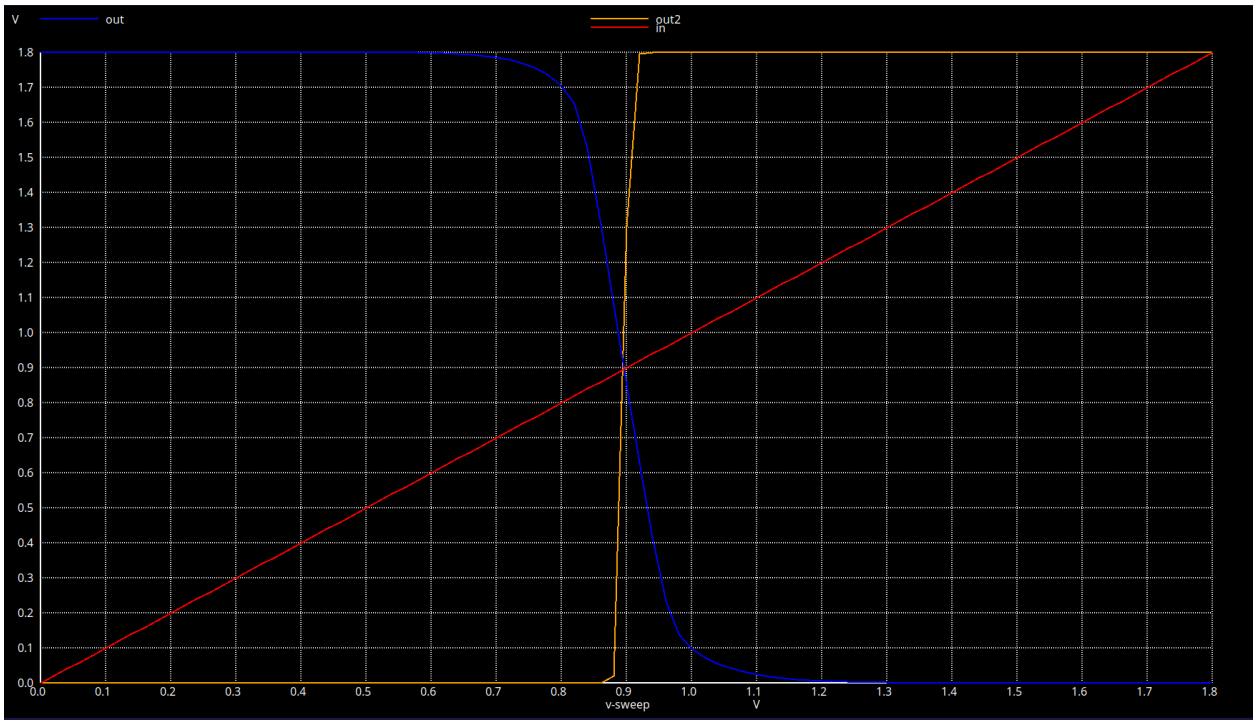
Q2. Design of INVX2 inverter (loaded with INVX1 inverter)

Doubling the width since it results in double the strength of inverter.

Inverter Design Parameter	Value
PMOS Width (µm)	2.5
PMOS Length (µm)	0.15
NMOS Width (µm)	0.8
NMOS Length (µm)	0.15

Inverter Dynamic Characteristics	Value
Rise Time (ps)	12
Fall Time (ps)	12
Propagation Delay (ps)	8

Inverter Static Characteristics	Value
VIH (V)	1.010
VIL (V)	0.773
NMH (V)	0.790
NML (V)	0.773
Switching Voltage, VM (V)	0.903



Ngspice Codes for both Questions

Q1 Code

```
* SkyWater PDK
* simple inverter

.lib /usr/local/share/pdk/sky130A/libs.tech/ngspice/sky130.lib.spice tt

* voltage source
Vdd vdd gnd DC 1.8
V1 in gnd pulse(0 1.8 0p 20p 20p 1n 2n)
```

```
Xnot1 in vdd gnd out not1
.subckt not1 a vdd vss z
xm01  z a  vdd vdd sky130_fd_pr__pfet_01v8 l=0.15 w=1.25 as=0.375 ad=0.375 ps=3.1 pd=3.1
xm02  z a  vss vss sky130_fd_pr__nfet_01v8 l=0.15 w=0.4 as=0.12 ad=0.12 ps=1.4 pd=1.4
.ends

Xnot2 out vdd gnd out2 not2
.subckt not2 a vdd vss z
xm03  z a  vdd vdd sky130_fd_pr__pfet_01v8 l=0.15 w=1.25 as=0.375 ad=0.375 ps=3.1 pd=3.1
xm04  z a  vss vss sky130_fd_pr__nfet_01v8 l=0.15 w=0.4 as=0.12 ad=0.12 ps=1.4 pd=1.4
.ends


*sim command
.dc V1 0 1.8 0.02

.control
run
plot in out out2
.endc
```

Q2 Code

```
* SkyWater PDK
* simple inverter

.lib /usr/local/share/pdk/sky130A/libs.tech/ngspice/sky130.lib.spice tt

* voltage source
Vdd vdd gnd DC 1.8
V1 in gnd pulse(0 1.8 0p 20p 20p 1n 2n)

Xnot1 in vdd gnd out not1
.subckt not1 a vdd vss z
xm01  z a  vdd vdd sky130_fd_pr__pfet_01v8 l=0.15 w=2.50 as=0.75 ad=0.75 ps=5.6 pd=5.6
xm02  z a  vss vss sky130_fd_pr__nfet_01v8 l=0.15 w=0.8 as=0.24 ad=0.24 ps=2.2 pd=2.2
.ends

Xnot2 out vdd gnd out2 not2
.subckt not2 a vdd vss z
xm03  z a  vdd vdd sky130_fd_pr__pfet_01v8 l=0.15 w=1.25 as=0.375 ad=0.375 ps=3.1 pd=3.1
xm04  z a  vss vss sky130_fd_pr__nfet_01v8 l=0.15 w=0.4 as=0.12 ad=0.12 ps=1.4 pd=1.4
.ends
```

```
*sim command
.dc V1 0 1.8 0.02

.control
run
plot in out out2
.endc
```