EE5311 Tutorial 2 Report - EE22B070

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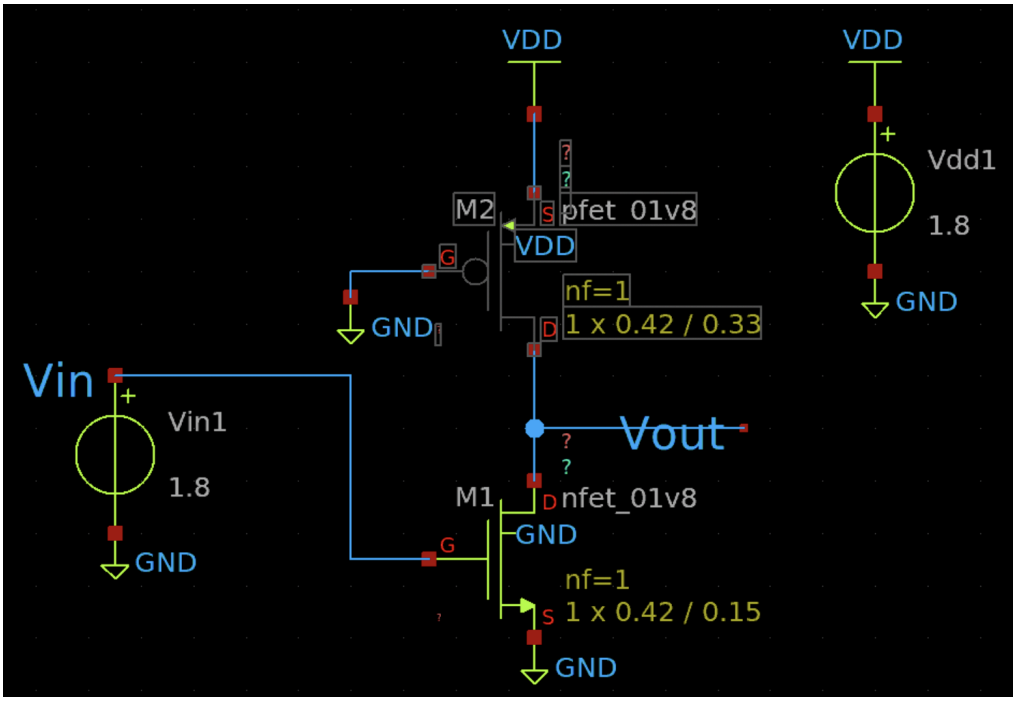
Question 1.

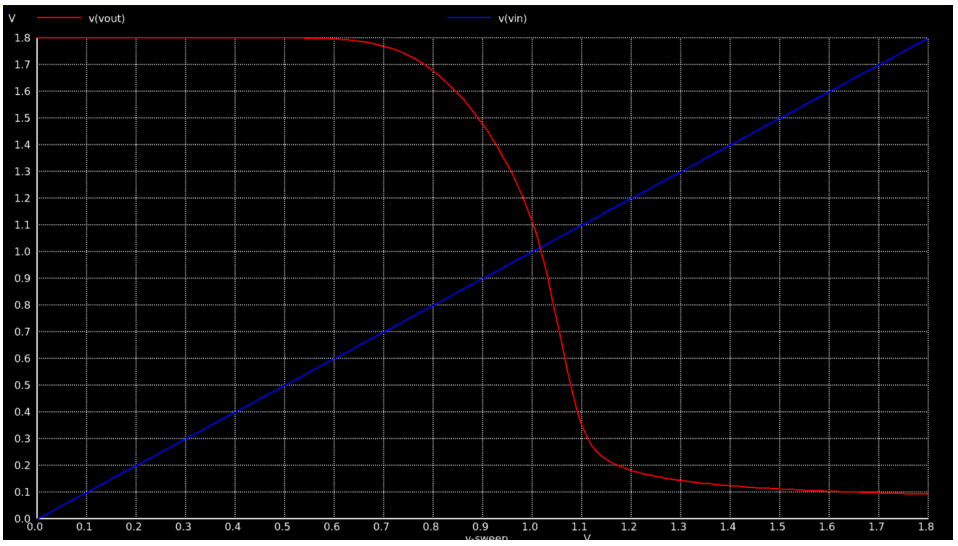
Schematic:



Schematic 1

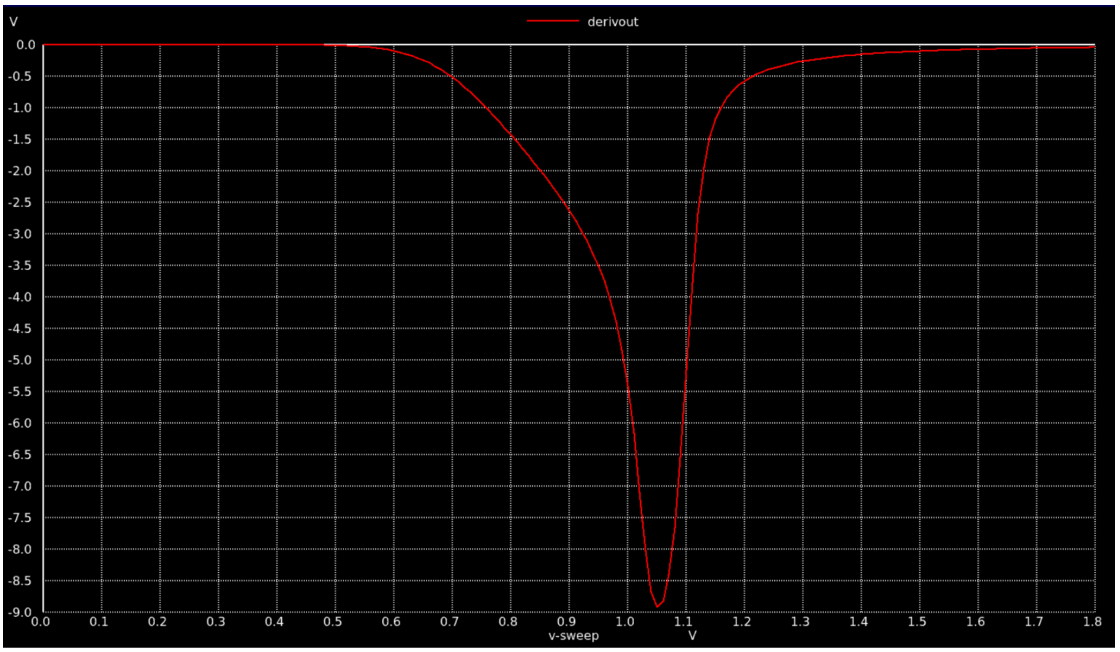
Measurement:

L_p = 0.32 micrometers



Plot 1: DC Characteristics of the pseudo-CMOS Inverter in Schematic 1, L_p = 0.32 µm

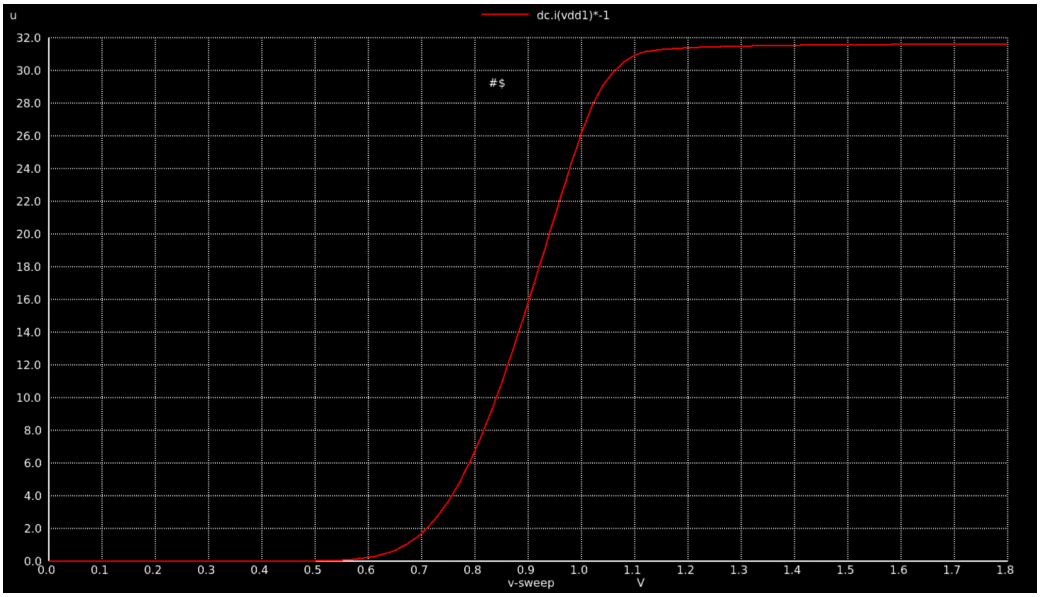
1.(b)



Plot 2: Derivative plot for Schematic 1 inverter.

```
vil                    =  7.57841e-01
vih                    =  1.158563e+00
vm                     =  1.031174e+00
NML: 0.757842 NMH: 0.641437
ngspice 2 ->
```

1.(c)

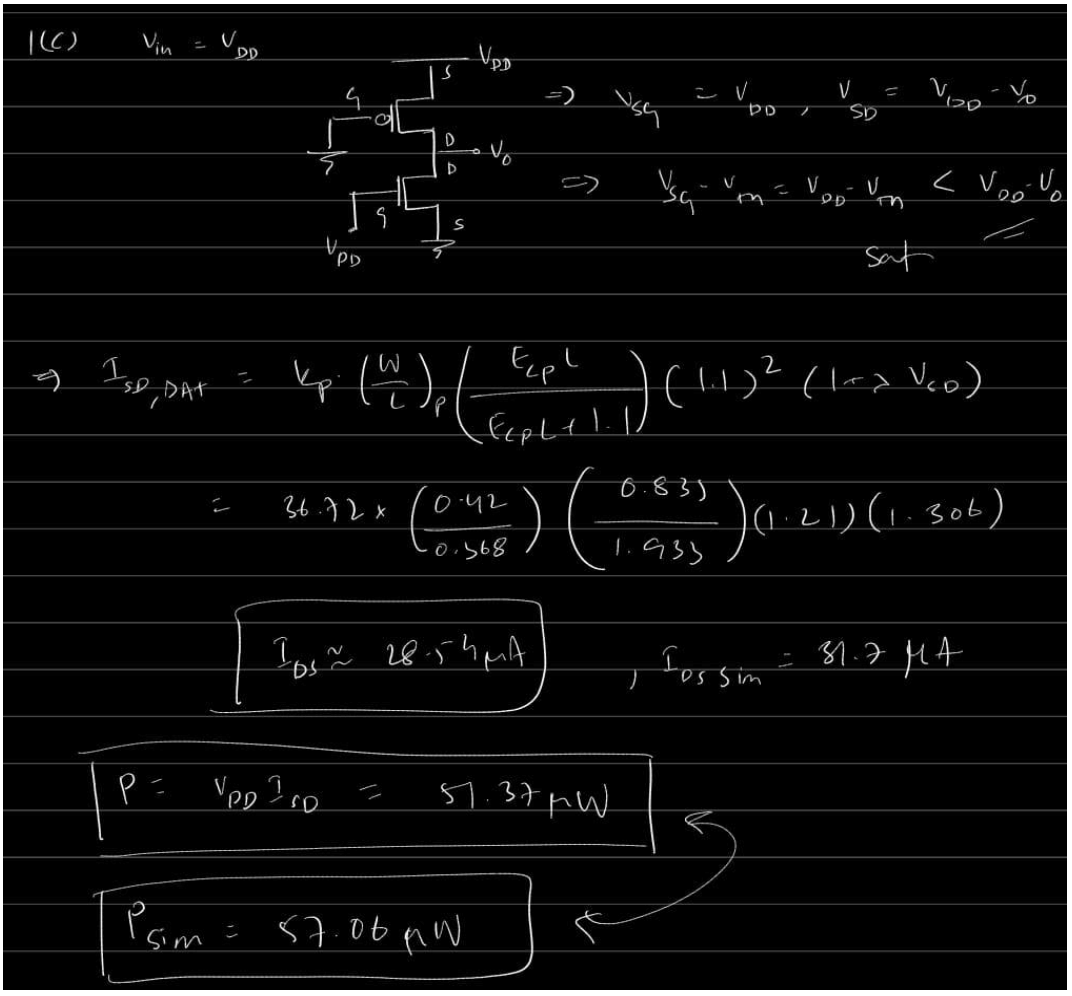



```
ngspice 2 ->
x0 = 1.7906, y0 = 3.14912e-05
```

Calculations:

1(a) $V_{inv(threshold)} = 0.89V$

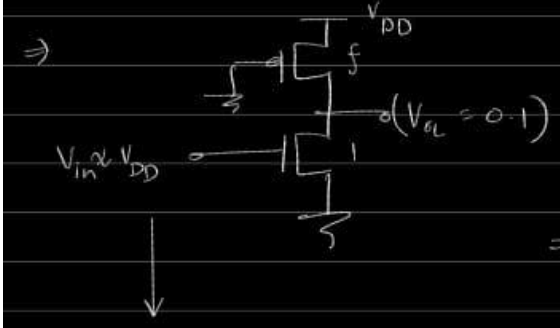
1(c)



pMOS Size calc.

1 (c)

$V_{OL} = 0.1\,V$ $\Rightarrow$ $V_{GS} = V_{DD}$, $V_{DS} = 0.1$



$V_{GS} - V_{TN} > V_{DS} \Rightarrow$ linear

$\Rightarrow$ $V_{SG} = V_{DD} - 0 = V_{DD} = 1.8\,V$

$V_{SD} = V_{DD} - 0.1 = 1.7$

$I_{DS/Lin} = k_n \left(\frac{E_{cn} L}{E_{cn} L + V_{GS} - V_{TN}}\right)\left[2(V_{GS} - V_{TN})V_{DS} + V_{DS}^2\right](1 + \lambda V_{DS})$

$V_{SG} - |V_{TP}| = 1.8 - 0.9 = 0.9V$

$V_{SG} - |V_{TP}| < V_{SD}$

$\therefore$ sat region

$= 104.2\left(\frac{0.96}{0.96 + 1.8 - 0.7}\right)\left(2(1.8 - 0.7)0.1 + (0.1)^2\right)(1.016)$

$= 11.37$

$I_{SD,sat} = k_p f \left(\frac{E_{cp} L}{E_{cp} L + V_{SG} - |V_{TP}|}\right)(V_{SG} - |V_{TP}|)^2 (1 + \lambda V_{DS})$

9/10

$I_{SD,sat} = 36.72 f \left(\frac{0.833}{0.833 + 1.8 - 0.7}\right)(1.8 - 0.7)^2 (1 + 0.18 \times (1.7))$

$= 36.72 f \times 0.431 \times 1.21 \times 1.306$

$= 25 f.$

$\therefore$ $f = \frac{11.37}{25}$

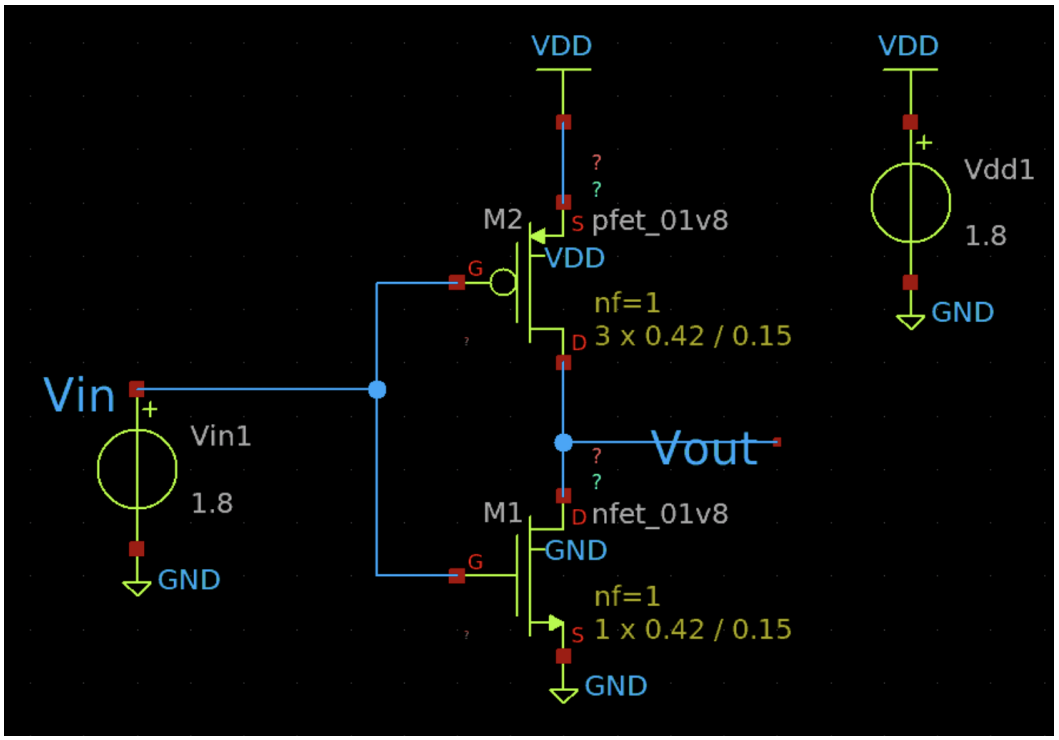
$\therefore$ $\left(\frac{W}{L}\right)_p = f \cdot \left(\frac{W}{L}\right)_n$

$\therefore$ $L_p = \frac{L_n}{f} \Rightarrow \frac{25}{10.19} \times 0.15$

$L_p \simeq 0.33\ \mu m$

Question 2.

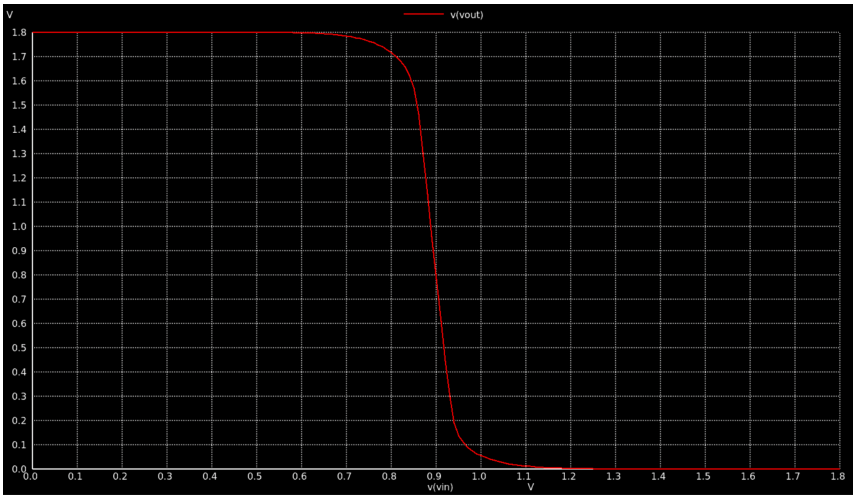
Schematic:



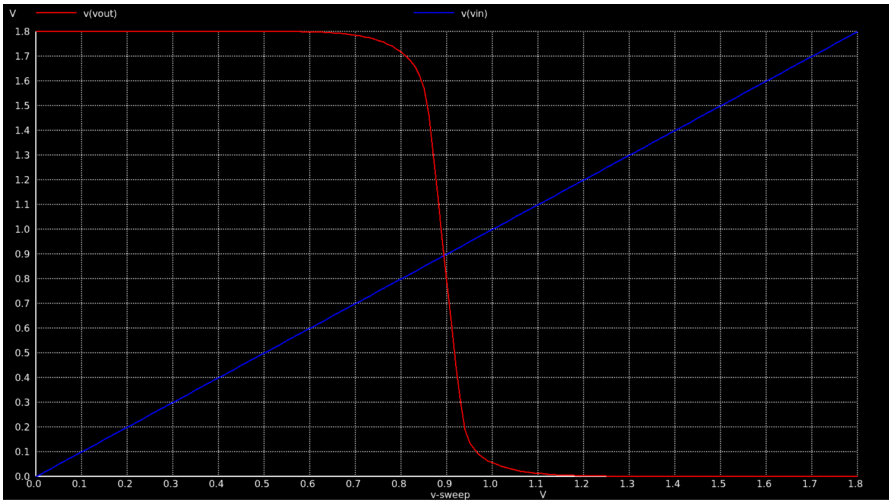
Schematic 2

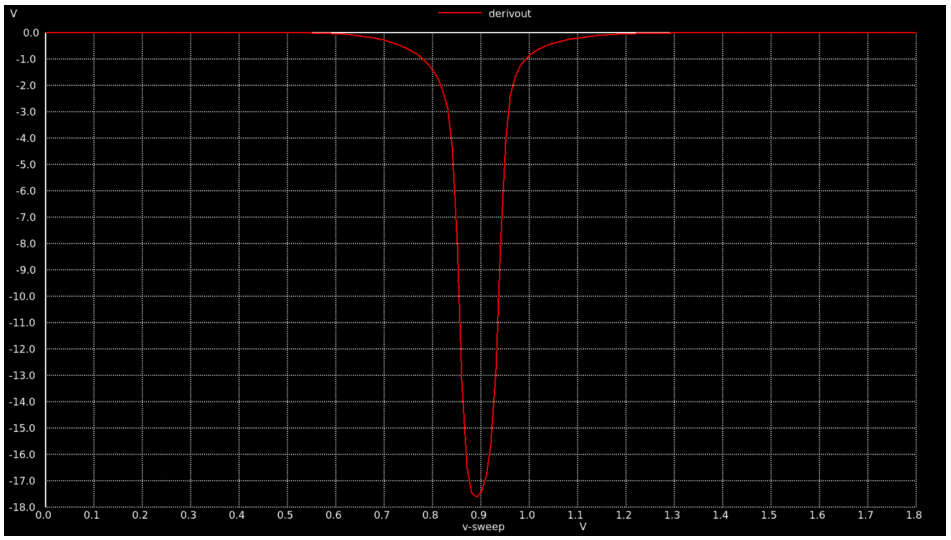
Measurement:

1(0)



1(a)

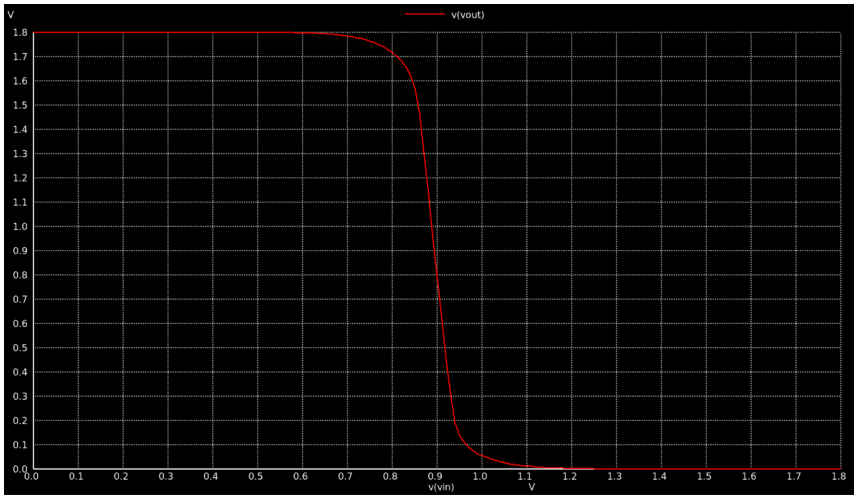


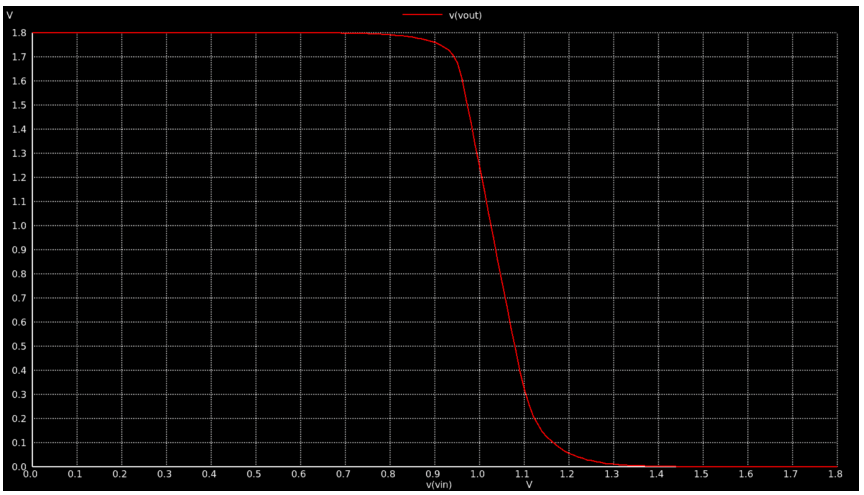



```
vil                    =  7.795111e-01
vih                    =  9.913325e-01
vm                     =  8.933287e-01
NML: 0.779511 NMH: 0.808667
ngspice 2 ->
x0 = 1.32051, y0 = -6.04545
ngspice 2 ->
```

1(b)

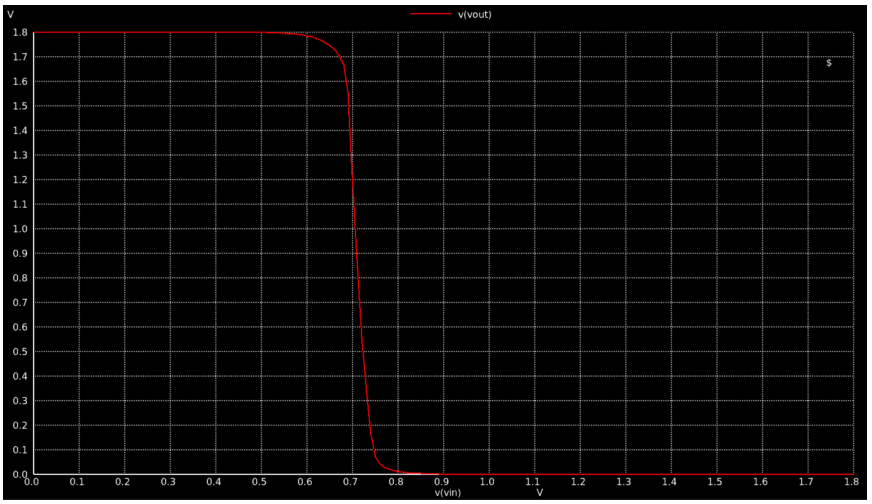
For 1x (W/L)



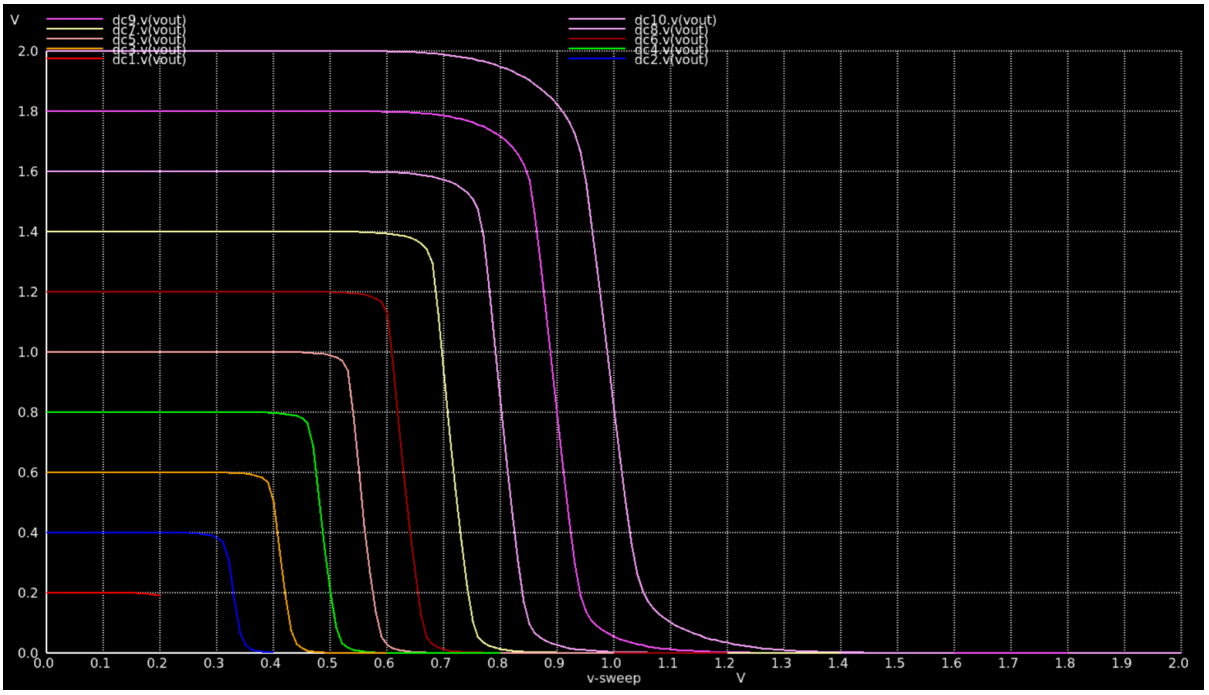


For 10x (W/L)

For 0.1x(W/L)

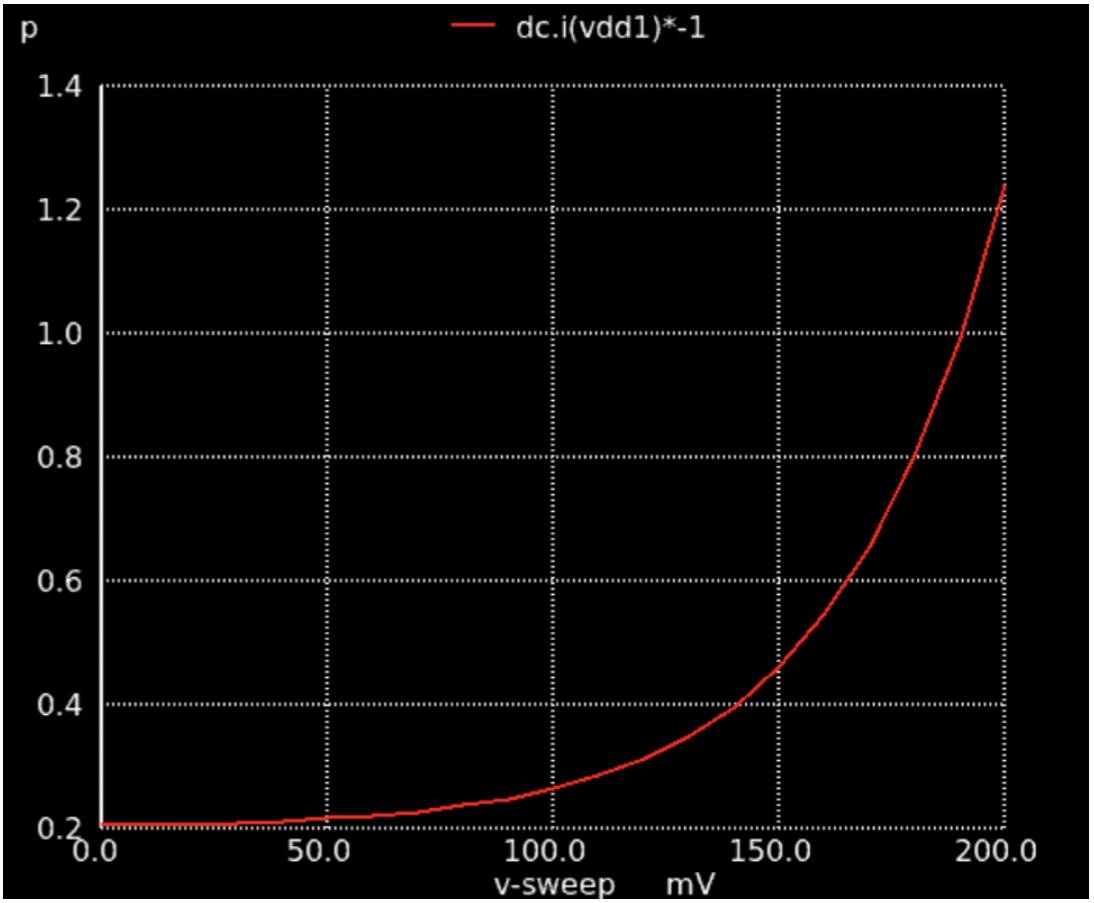


1(c)

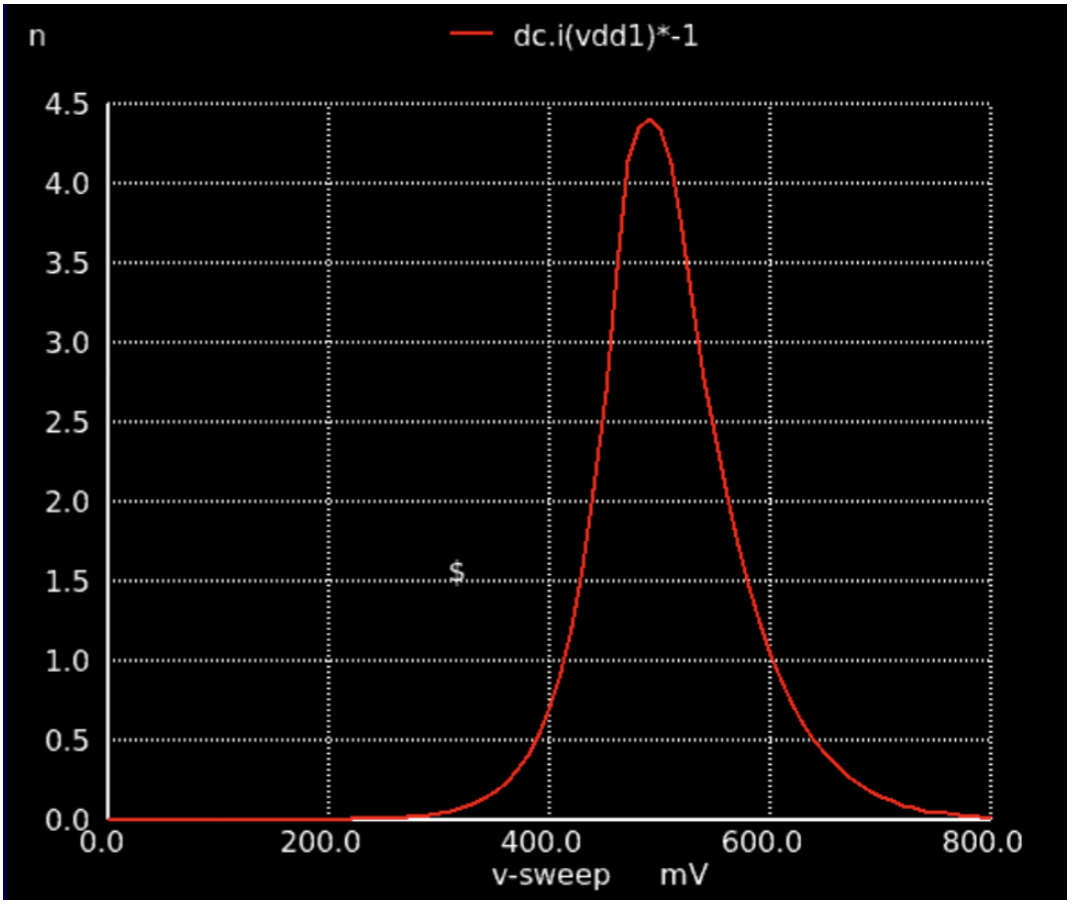


DC Characteristics of various Vdd values.

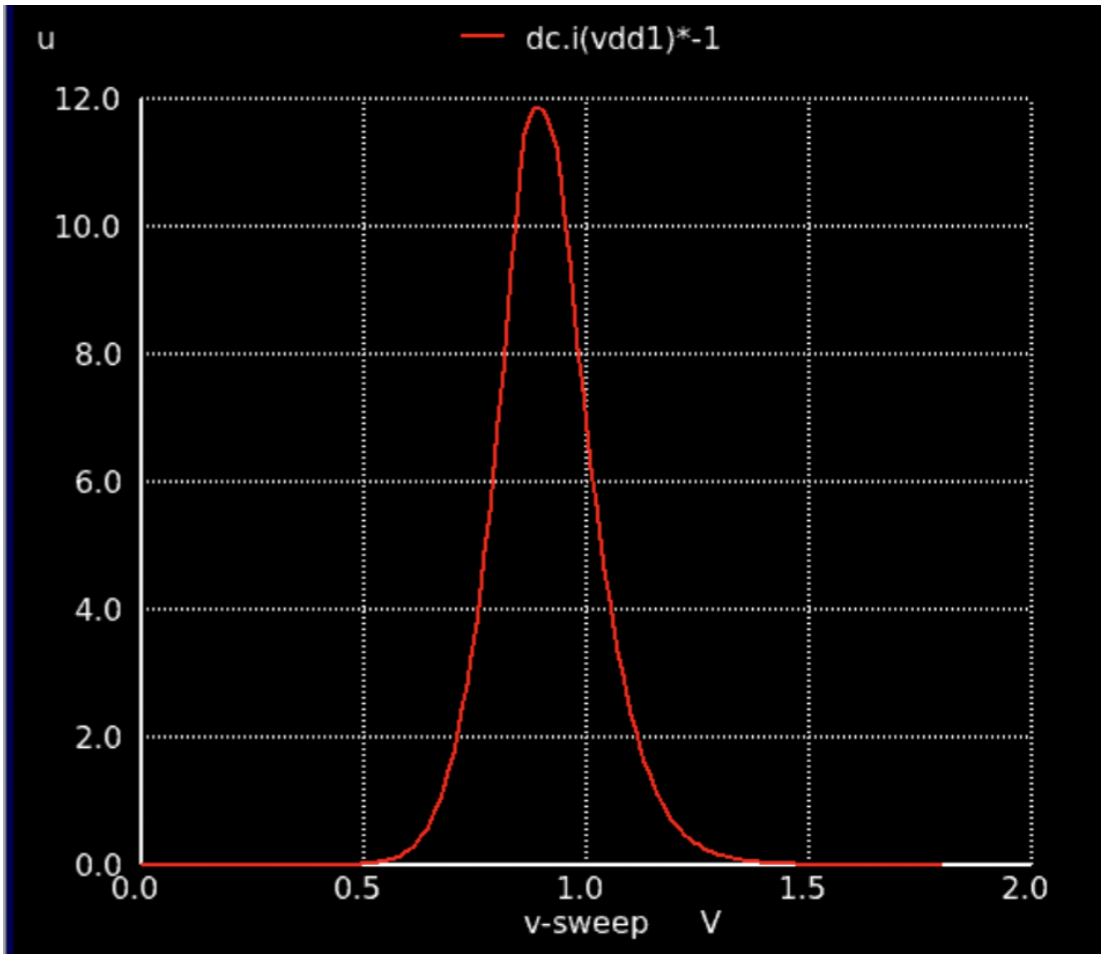
1(d)



For vdd = 0.2V



For vdd = 0.8V



For vdd = 1.8V

Calculations:

pMOS Sizing