

EE141-Fall 2012 Digital Integrated Circuits

Lecture 10
Using the MOS Model:
Inverter VTC

Announcements

- Homework #5 due Thursday
 - Homework #6 out next week

- Midterm #1 Thurs. Oct. 4th, 6:30-8:00pm
 - Location TBD
 - Exam is open notes, book, calculators, etc.
 - Midterm review session next week

- Elad out of town this Thurs. and Fri.
 - Thurs. lecture will be taped ahead tomorrow (Wed.) 11am-12:30pm – location TBD

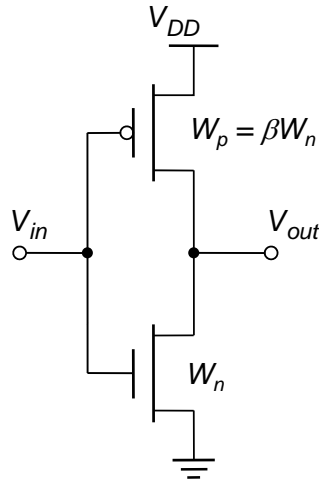
Class Material

- Last lecture
 - MOS Transistor Model
- Today's lecture
 - Using the MOS Model: Inverter VTC
- Reading (5.1-5.3)

CMOS Inverter VTC



The CMOS Inverter



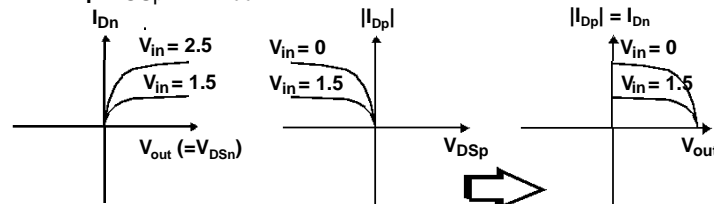
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5

PMOS Load Lines

- For DC VTC, $I_{Dn} = I_{Dp}$
 - Graphically, looking for intersections of NMOS and PMOS IV characteristics
- To put IV curves on the same plot, PMOS IV is “flipped” since $|V_{DSp}| = V_{DD} - V_{out}$
 - Also, $|V_{GSp}| = V_{dd} - V_{in}$



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6

Note on Transistor IV Problems

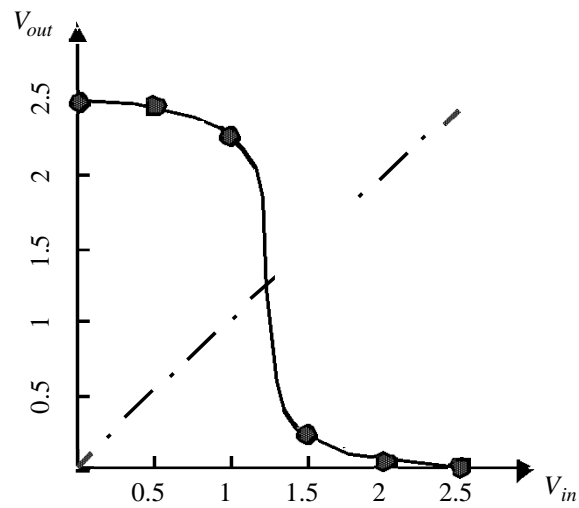
- “Guess and Check”
 - Guess region(s) of operation
 - Check consistency

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7

CMOS Inverter VTC

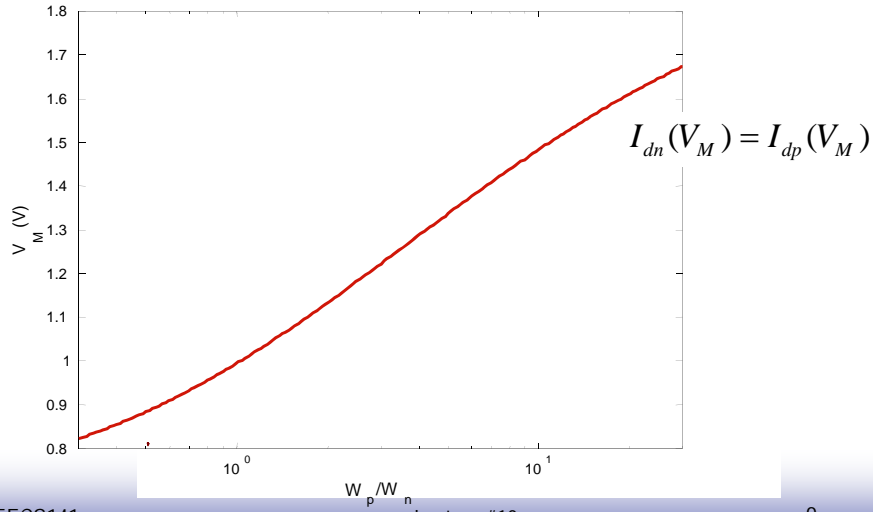


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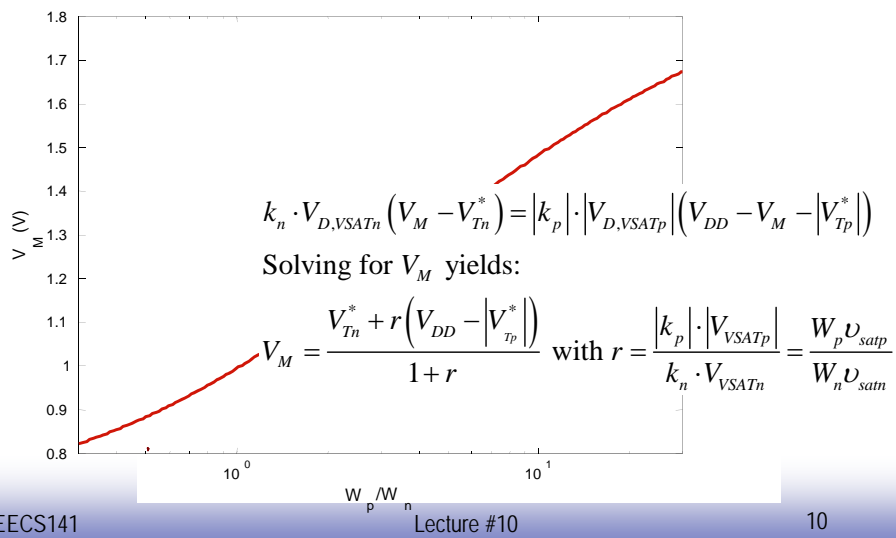
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8

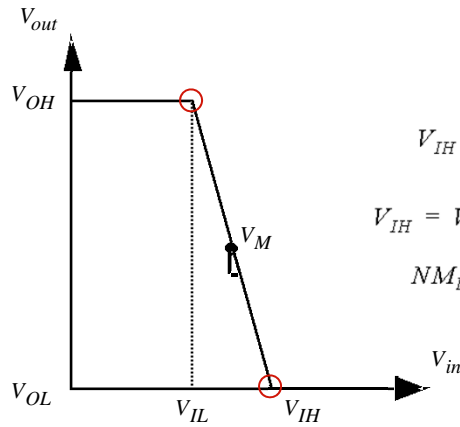
Switching Threshold as a Function of Transistor Ratio



Switching Threshold as a Function of Transistor Ratio



Determining V_{IH} and V_{IL}



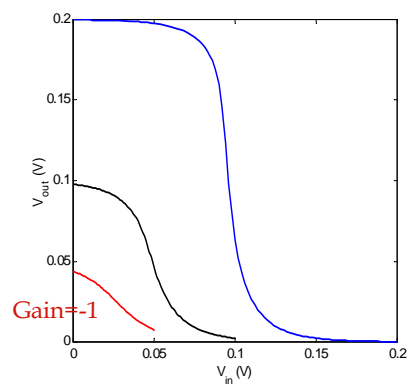
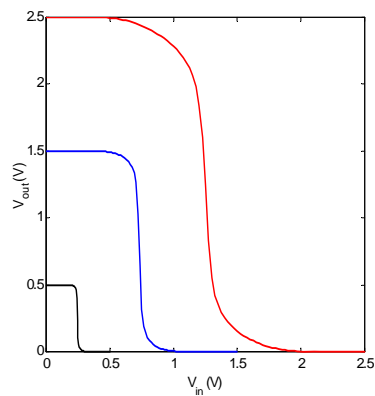
$$V_{IH} - V_{IL} = -\frac{(V_{OH} - V_{OL})}{g} = \frac{-V_{DD}}{g}$$

$$V_{IH} = V_M - \frac{V_M}{g} \quad V_{IL} = V_M + \frac{V_{DD} - V_M}{g}$$

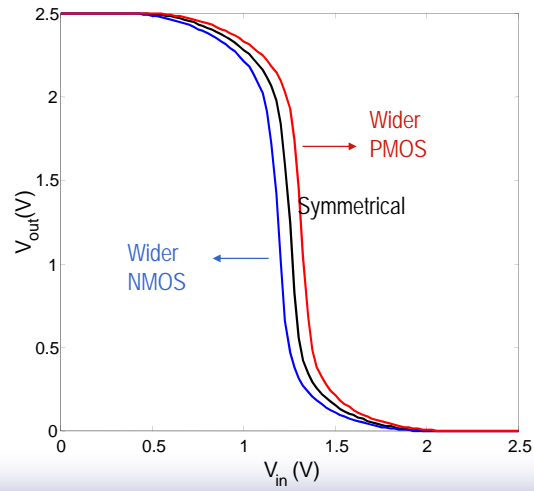
$$NM_H = V_{DD} - V_{IH} \quad NM_L = V_{IL}$$

A simplified approach

Gain as a function of VDD



Impact of Sizing



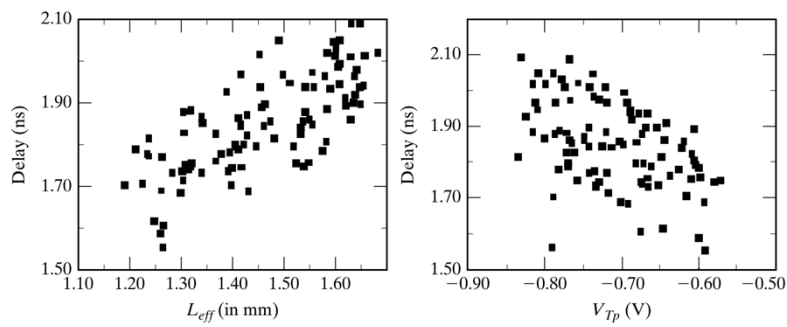
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13

Process Variations

Not all transistors are alike
Impacts parameters such as reliability and performance



Define process corners: SS, FF, SF, FS

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14

Impact of Process Variations

