

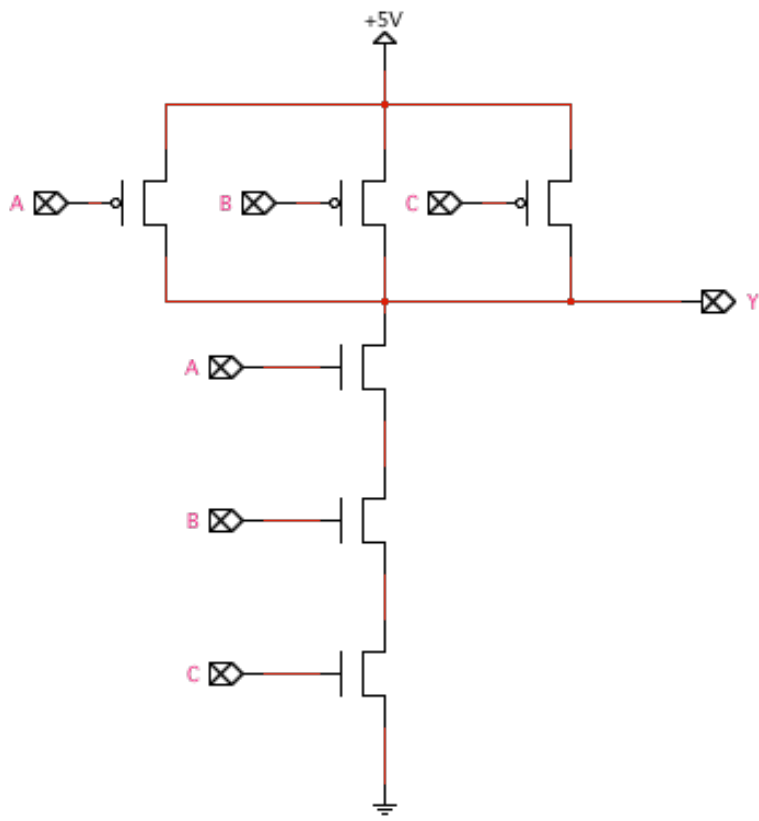
TRANSISTOR BASICS

- Transistors are a fundamental electrical component.
- Digital logic uses transistors as on-off switches.
- MOSFET transistors come in two main types: N-type and P-type
- A voltage at the gate input turns the transistor switch on or off.
- N-type gate behavior: 0 = off, 1 = on
- P-type gate behavior: 0 = on, 1 = off
- Note that the behavior of N type and P-type is just opposite.
- One way to remember N-type turns on with gate = 1 is to note that “on” would spell “one” if there was just one more letter!

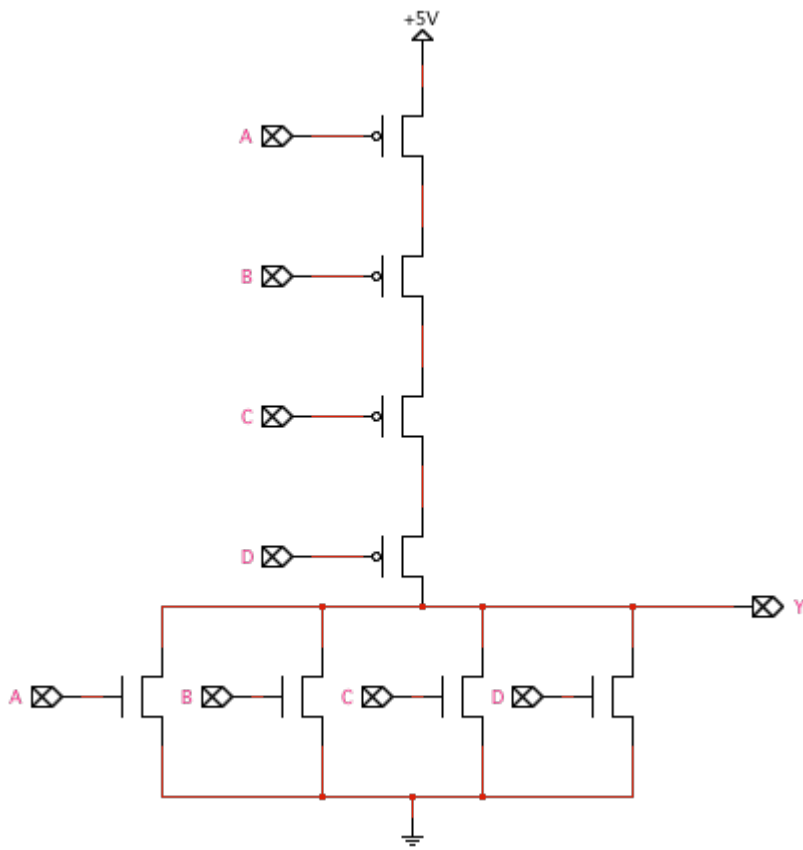
CMOS TRANSISTOR CIRCUIT RULES-OF-THUMB

- Circuit is divided into two planes: N-plane and P-plane
- Each plane contains only that type of transistor.
- N-plane pulls output down to logic 0.
- P-plane pulls output up to logic 1.
- Goal in design: only one plane should be pulling at a time!
- CMOS always creates complement logic (bubble on the output).
- Add a second stage inverter to create non-complemented logic.
- Memorize the N-plane rules. The P-plane rules are just opposite.
- Transistor planes connect at the plane junction. This becomes the output node.

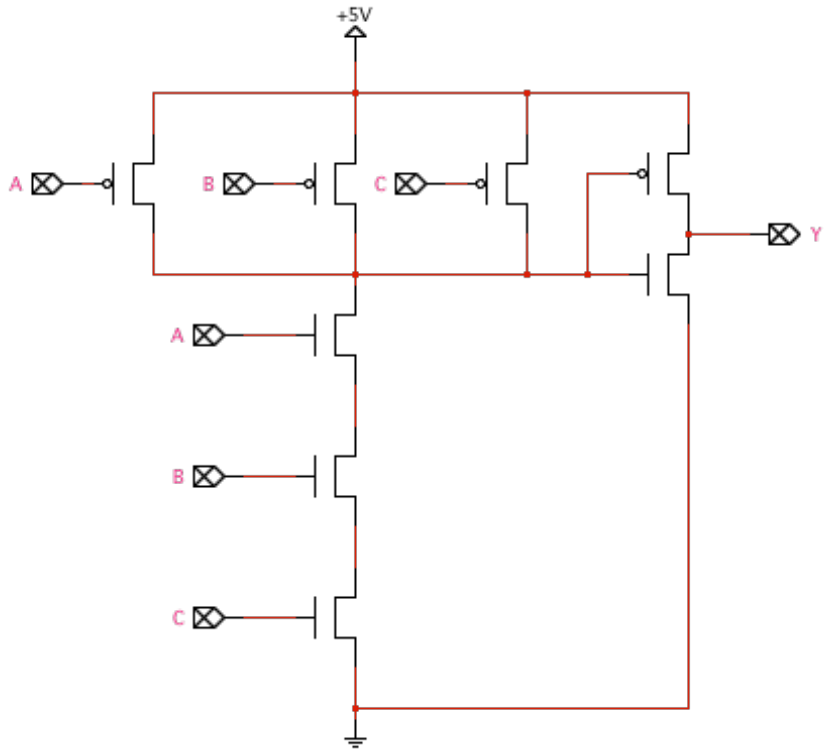
BEHAVIOR	N-PLANE	P-PLANE
n-input NAND	n transistors in series	n-transistors in parallel
n-input NOR	n transistors in parallel	n-transistors in series



CMOS NAND3



CMOS NOR4



CMOS AND3
Note the second stage inverter