Boolean logic in CMOS

Representations of Boolean logic

- Truth table
- Boolean equation
- Circuit element (gate)

Truth table

- Brute force I/O specification
- Grows exponentially with number of inputs

Boolean algebra

- Identities

  x + 0 = x

  x + 1 = 1

  x + x = x

  x + x’ = 1

  x’’ = x

  x * 1 = x

  x * 0 = 0

  x * x = x

  x * x’ = 0

Boolean algebra

- Commutativity

  $x + y = y + x$

  $x * y = y * x$

- Associativity

  $x + (y + z) = (x + y) + z$

  $x * (y * z) = (x * y) * z$

Boolean algebra

- Distributive

  $x * (y + z) = x*y + x*z$

  $x + (y * z) = (x+y) * (x+z)$

  $= x + xy + xz + yz$

  $= x(1+y) + xz + yz$

  $= x + xz + yz$

  $= x(1+z) + yz$

  $= x + yz$

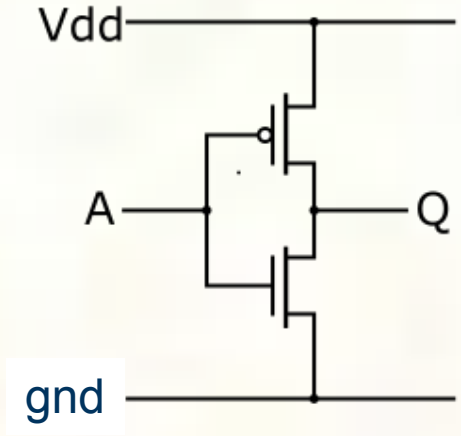
- De Morgan

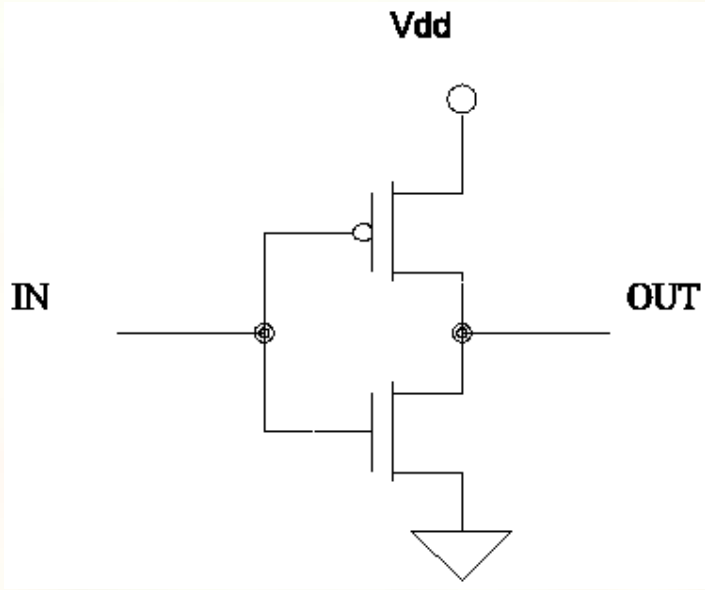
  $(x + y)' = x' * y'$

  $(x * y)' = x' + y'$

CMOS gates - NOT

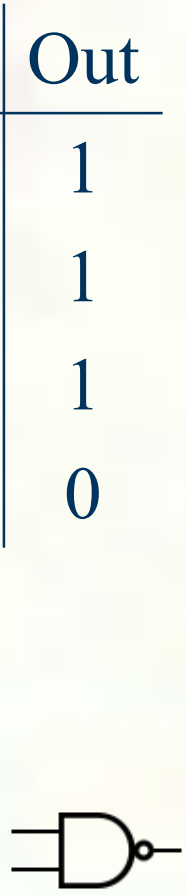
In	Out
0	1
1	0

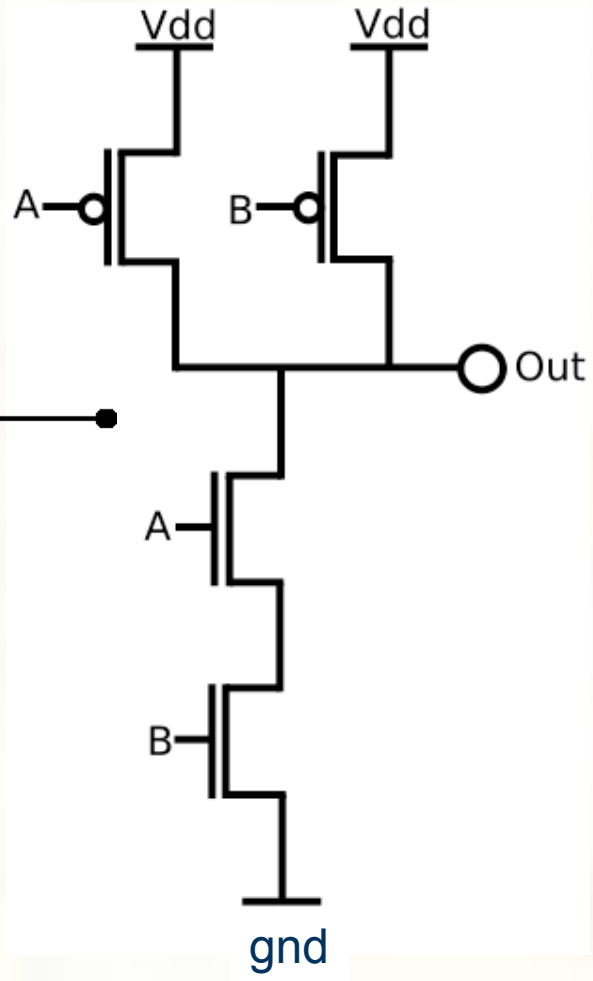




CMOS gates - NAND

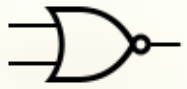
A	B	Out
0	0	1
0	1	1
1	0	1
1	1	0

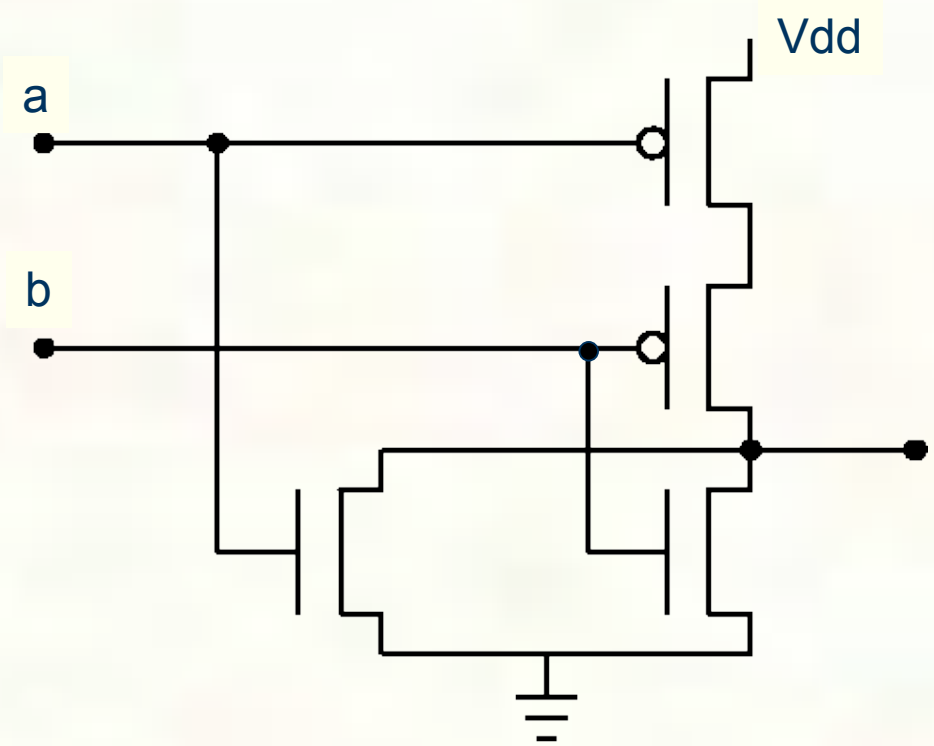




CMOS gates - NOR

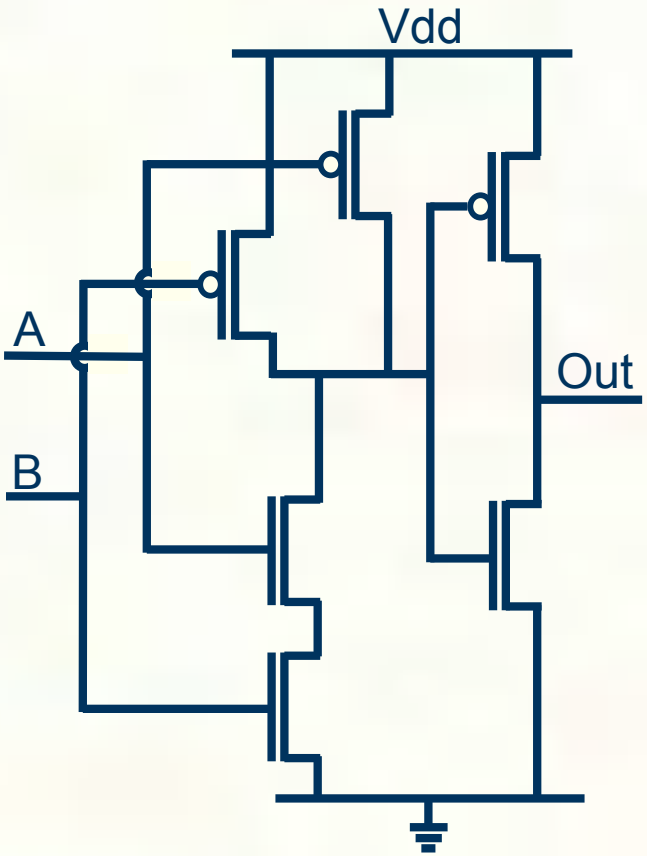
A	B	Out
0	0	1
0	1	0
1	0	0
1	1	0

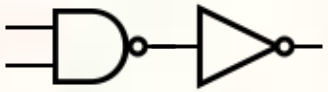


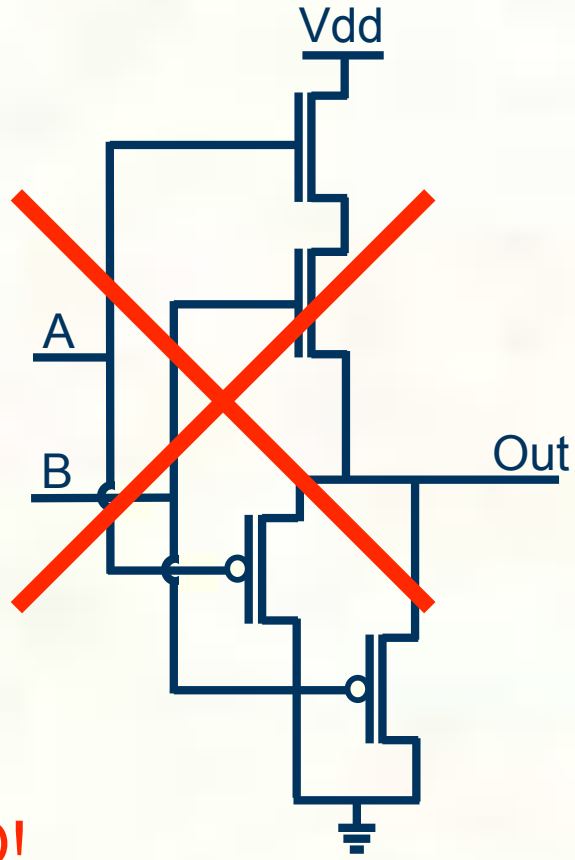


CMOS gates - AND

A	B	Out
0	0	0
0	1	0
1	0	0
1	1	1







NO!

Logically correct, but violates n to n and p to p rule, passes weak values

CMOS gates - OR

A	B	Out
0	0	0
0	1	1
1	0	1
1	1	1