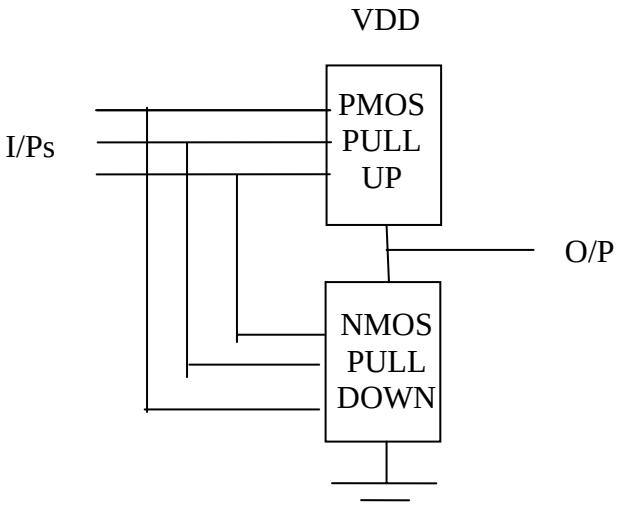
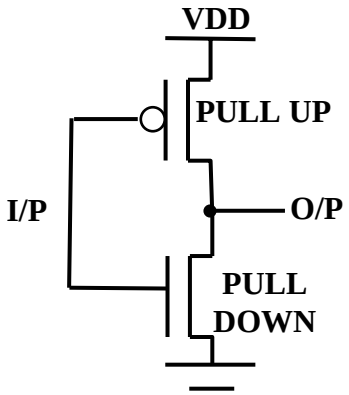
Complex CMOS Logic Gate

Basic Structure





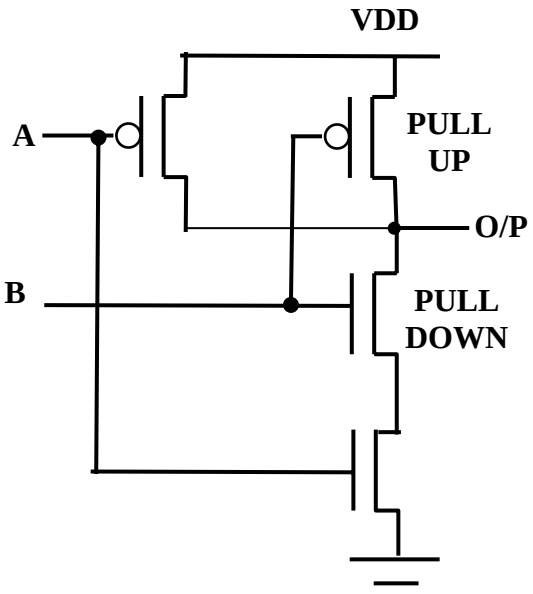
The Pull-Up (PU) block is a network of PMOS transistors

The Pull-Down (PD) block is a network of NMOS transistors

Simple Gates

1) 2 I/P NAND $F = \overline{A\,B}$

A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

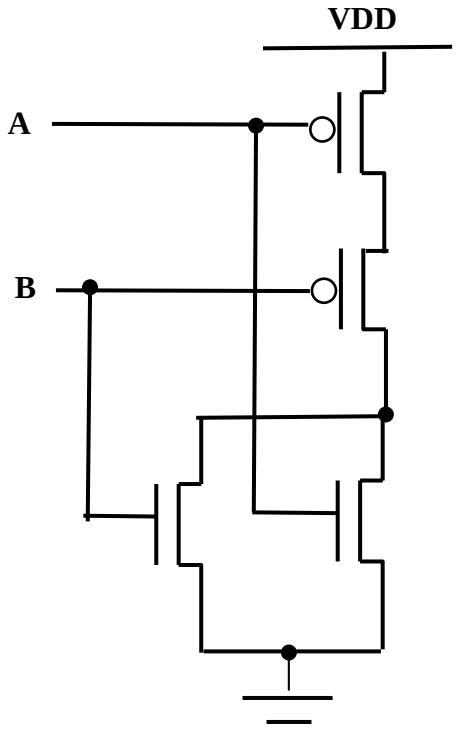


F = 0 only if both A & B = 1
→ 2 NMOS transistors in series
The PMOS block is always the complement of the N-MOS block
→ 2 PMOS transistors in parallel.

2) 2 I/P NOR $F = \overline{A + B}$

A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

F = 1 only if both A & B = 0



2 PMOS in series & the NMOS block is the complemented (i.e parallel)

Methodology for obtaining the CMOS implantation of any Boolean expression:

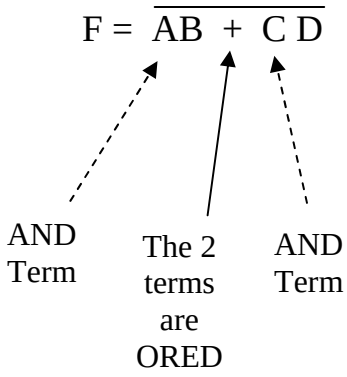
1) Any Boolean expression that is complemented (i.e in the form $\overline{(A+B).C}$) can be implemented using a single CMOS Gate (i.e a circuit with only one output F) → If the function is not complemented and/or some of the I/P's are complemented (e.g (A+B).C or $\overline{(\overline{A}+B).C}$)

Then It cannot be implemented using a single CMOS Gate → we have to do some logic transformation to implement it using minimum number of Gates or logic levels.

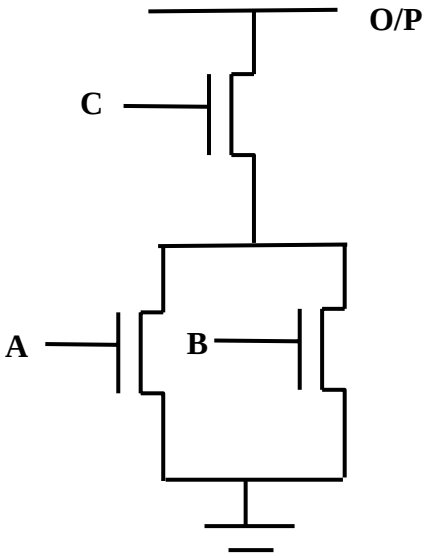
2) The output of a CMOS Gate is always complemented i.e we get the complement automatically

3) implement the NMOS block :
AND terms → series connected NMOSFET's
OR terms → paralleled connected PMOSFET's

Terms that are ANDed are connected in series
Terms that are ORed are connected in parallel



example $\overline{(A + B) . C}$

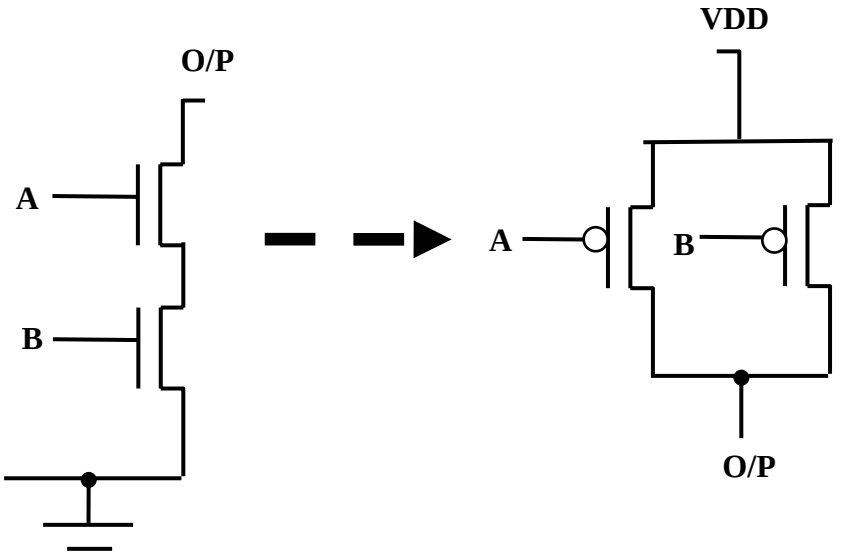


4) The PMOS block is the complemented of the NMOS block

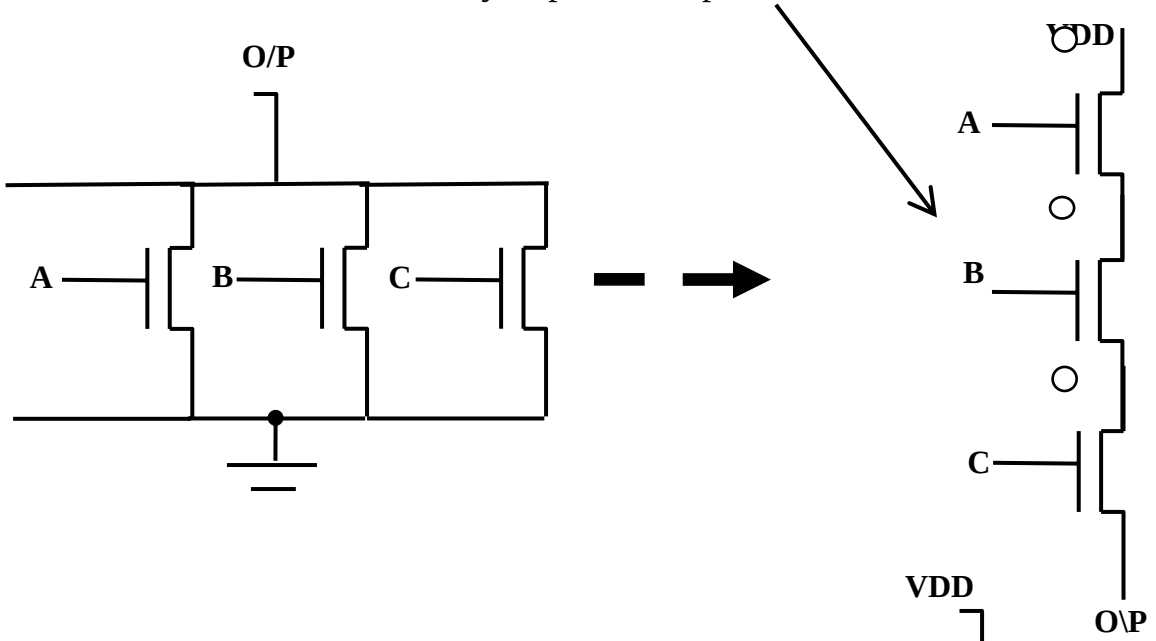
Series terms → become Parallel
Paralleled terms → become Series

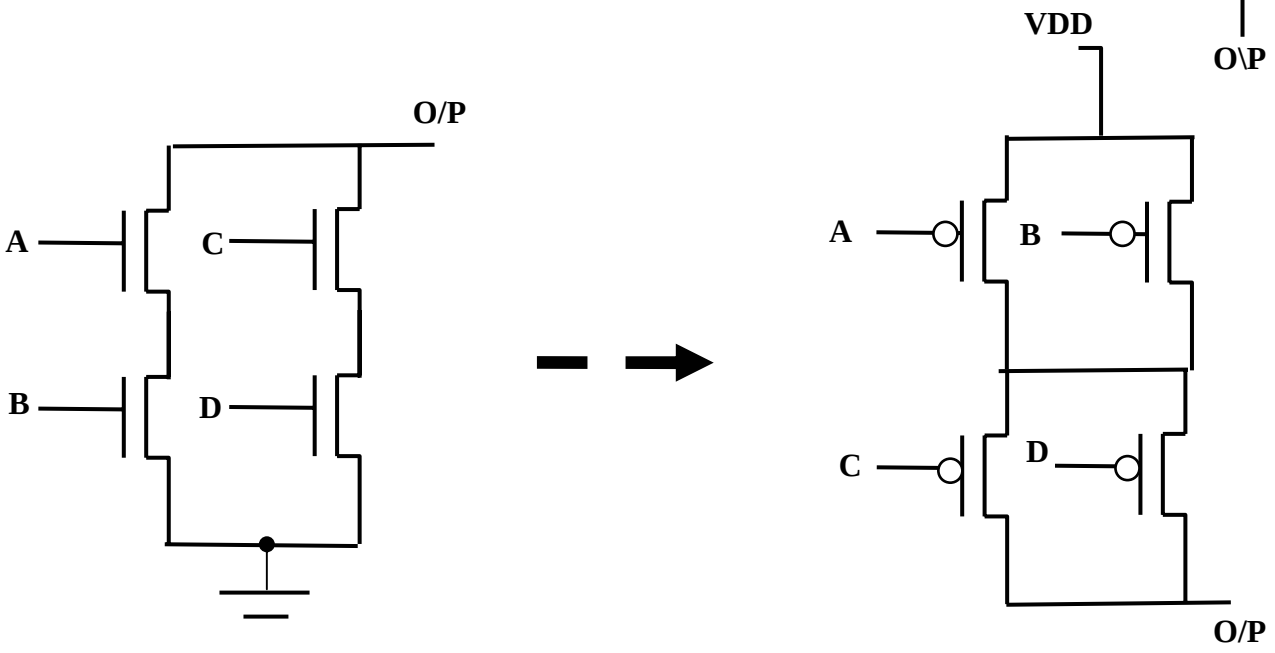
Terms that are connected in series → become connected in parallel
Terms that are connected in parallel → become connected in series

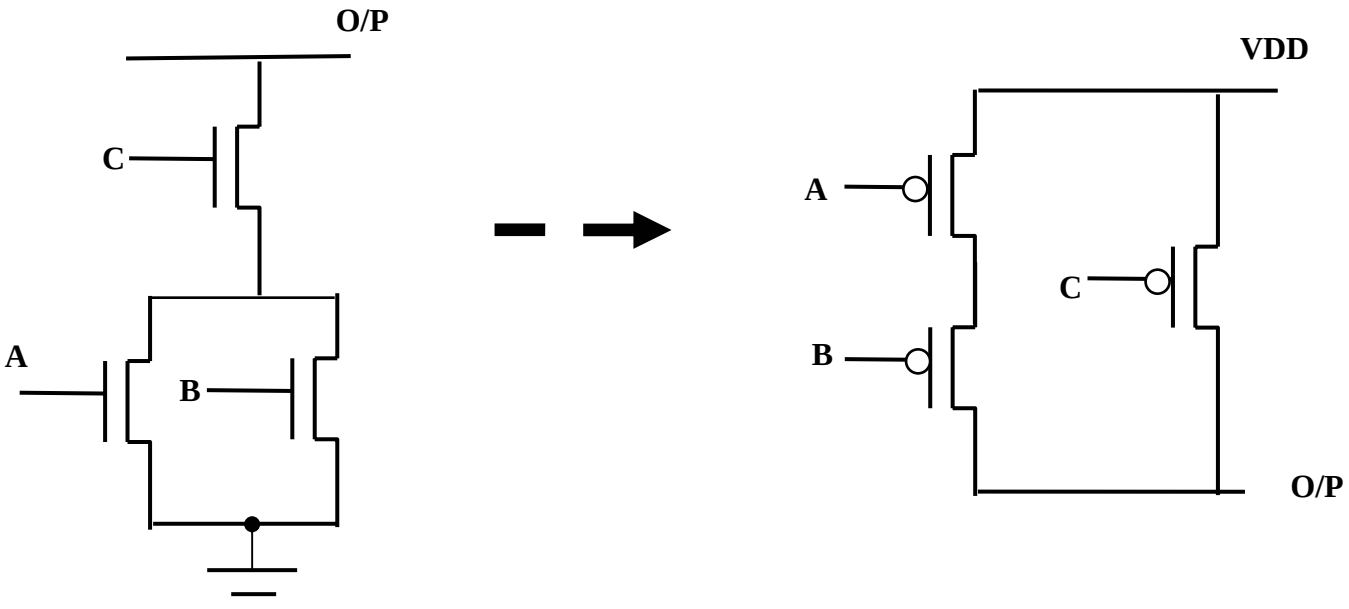
Examples



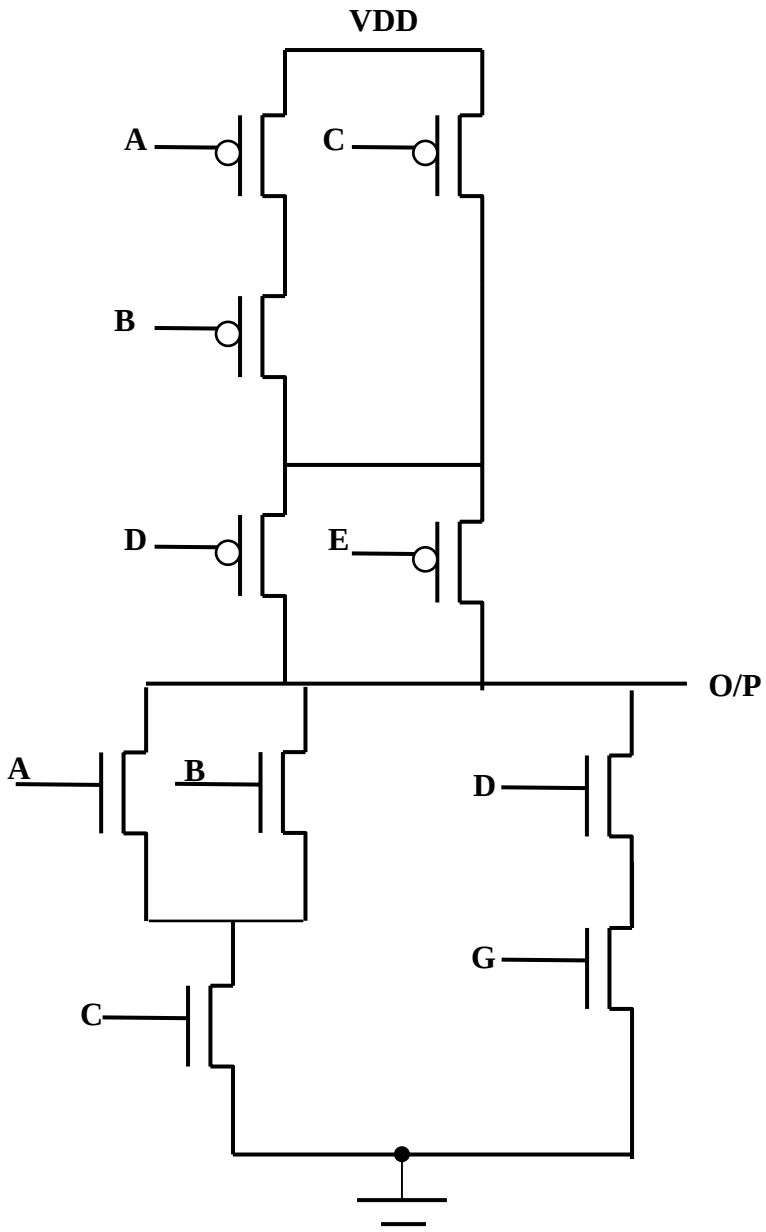
Order is not important in functionality,
it is only important in performance.







Ex1] Implement: $F = \overline{(A + B) . C + D G}$



Ex2]

$$F = \overline{A\,(\,B + C\,(\,D + G.E\,)\,)}$$