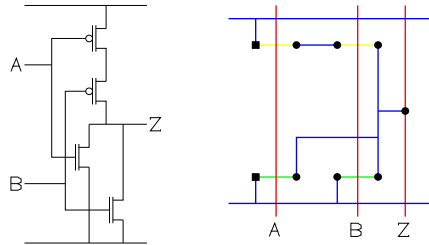


## Digital CMOS Design

### A logical approach to gate layout.

- All complementary gates may be designed using a single row of n-transistors above or below a single row of p-transistors, aligned at common gate connections.

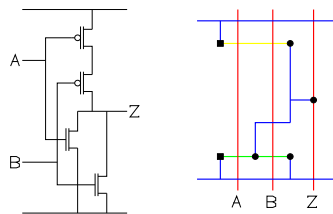


5001

## Digital CMOS Design

### Euler Path

- For the majority of these gates we can find an arrangement of transistors such that we can butt adjoining transistors.
  - Careful selection of transistor ordering.
  - Careful orientation of transistor source and drain.
- Referred to as *line of diffusion*.



5002

## Digital CMOS Design

### Finding an Euler Path

#### Computer Algorithms

- It is relatively easy for a computer to consider all possible arrangements of transistors in search of a suitable Euler path. This is not so easy for the human designer.

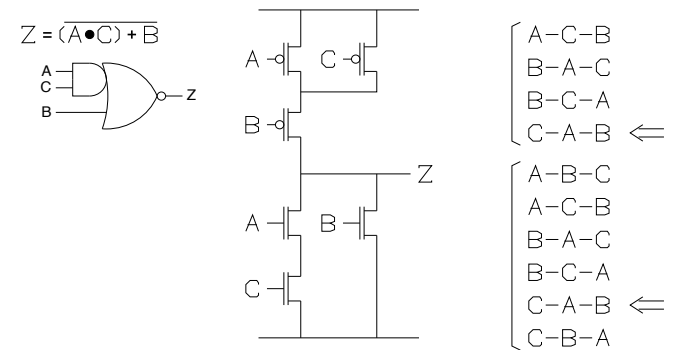
#### One Human Algorithm

- Find a path which passes through all n-transistors exactly once.
- Express the path in terms of the gate connections.
- Is it possible to follow a similarly labelled path through the p-transistors?
  - Yes - you've succeeded.
  - No - try again (you may like to try a p path first this time).

5003

## Digital CMOS Design

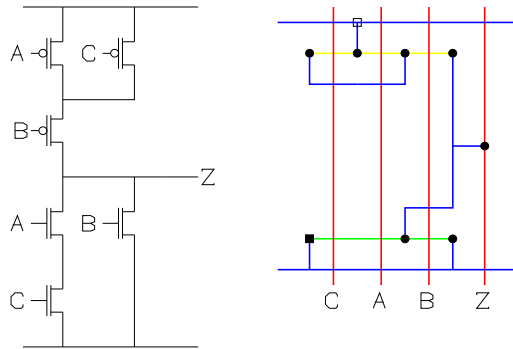
### Finding an Euler Path



Here there are four possible Euler paths.

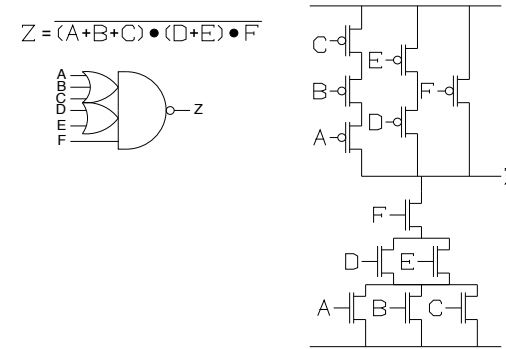
5004

Finding an Euler Path



5005

Finding an Euler Path

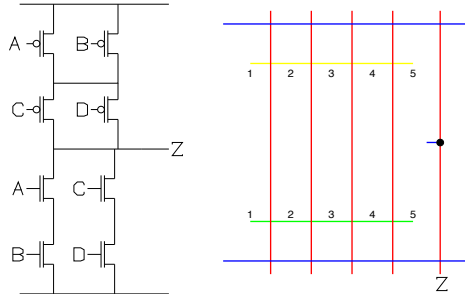


No possible path through n-transistors!

5007

Euler Path Example

$$Z = (A \cdot B) + (C \cdot D)$$



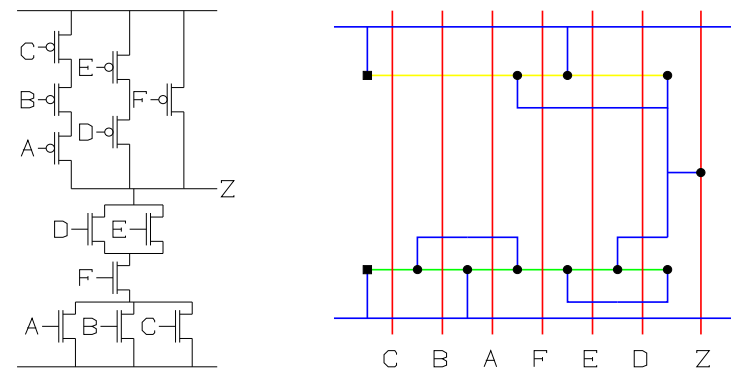
1. Find Euler path
  2. Label poly columns
  3. Route power nodes
  4. Route output node
  5. Route remaining nodes
  6. Add taps<sup>1</sup> for PMOS and NMOS
- A combined contact and tap, ■, may be used only where a power contact exists at the end of a line of diffusion. Where this is not the case a simple tap, □, should be used.

<sup>1</sup>1 tap is good for about 6 transistors - insufficient taps may leave a chip vulnerable to latch-up

5006

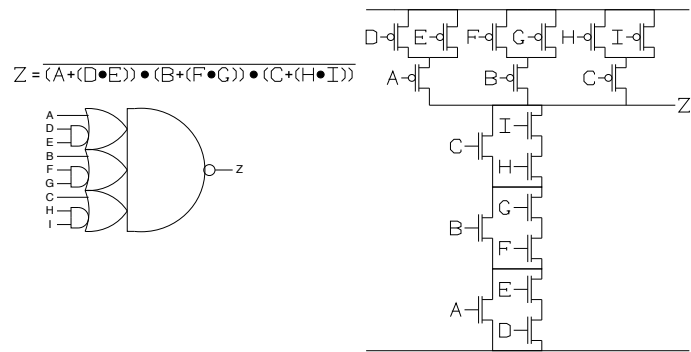
Finding an Euler Path

$$Z = (A+B+C) \cdot (D+E) \cdot F$$



5008

Finding an Euler Path



No possible path through p-transistors.  
 No re-arrangement will create a solution!