ECE321 – Electronics I

Lecture 22: Combinational Logic: Transmission Gates

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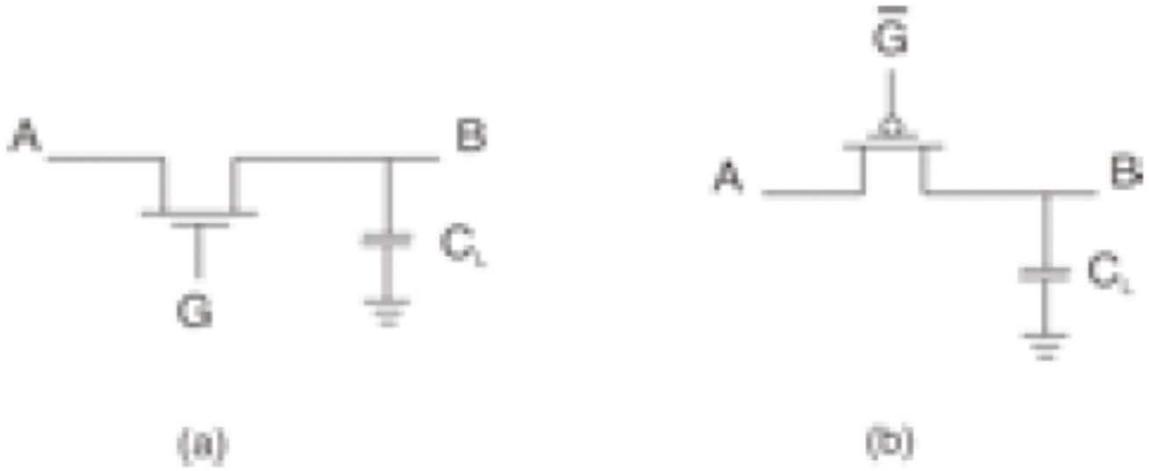
Review of Last Lecture

- **NAND Gate**
  - Basic circuit for CMOS NAND Gate
  - Circuit analysis techniques
  - Proper transistor sizing
- **NOR Gate**
  - Basic circuit for CMOS NOR Gate
  - Circuit analysis techniques
  - Proper transistor sizing

Today's Lecture

- **Transmission Gates**
  - **Basic circuit for Transmission Gate**
  - **Circuit analysis Techniques**
  - **Complex Logic Gates using Pass Transistors**

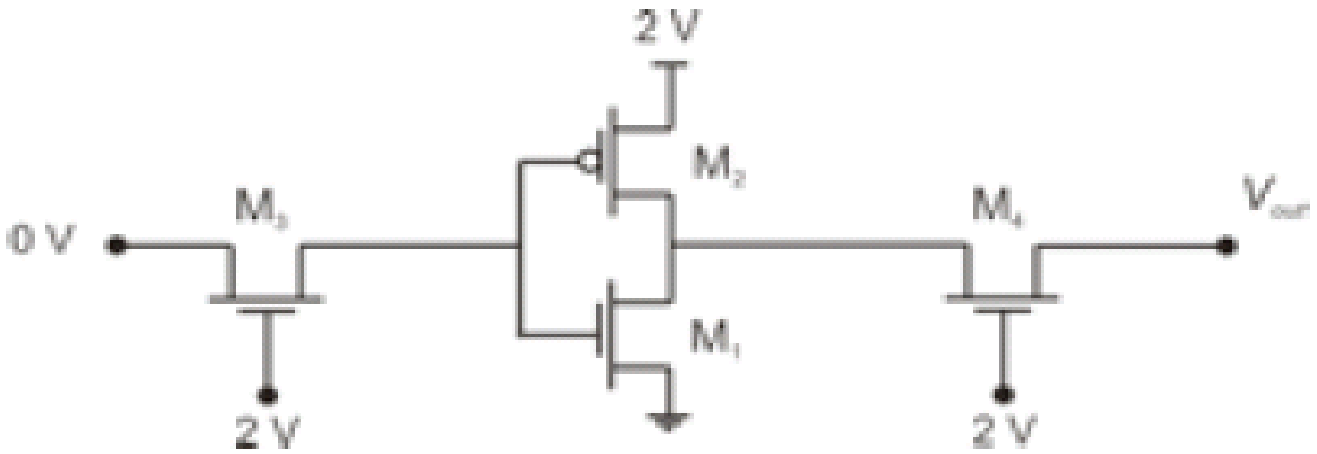
NMOS and PMOS as Switching Elements



- In circuit (a), if A has a full swing, what is the range of output voltages?
- In circuit (b), if A has a full swing, what is the range of output voltages?

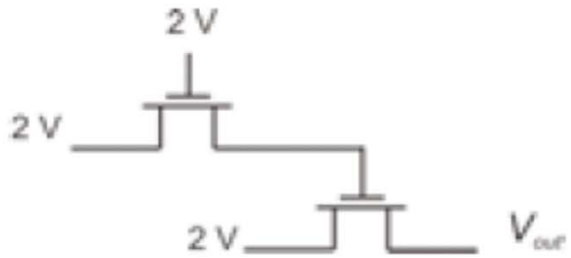
Example 1: Transmission Buffer

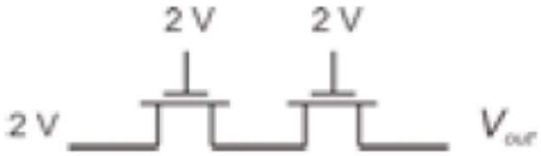
- Assuming |Vtp|=Vtn=0.5V, what is Vout?



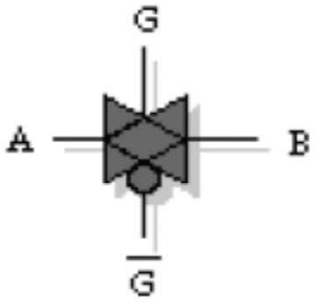
Example 2: Some Other Examples

Given the pass transistor circuit with $V_{in} = 0.5$ V. Ignore the body effect. What is the output voltage?





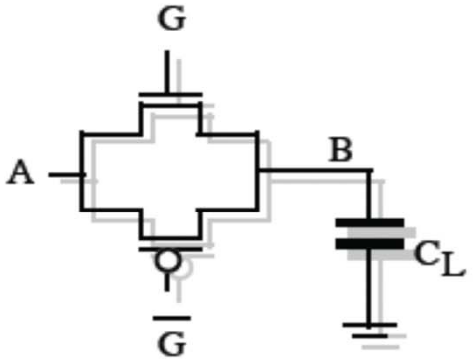
CMOS Transmission Gate



(a)

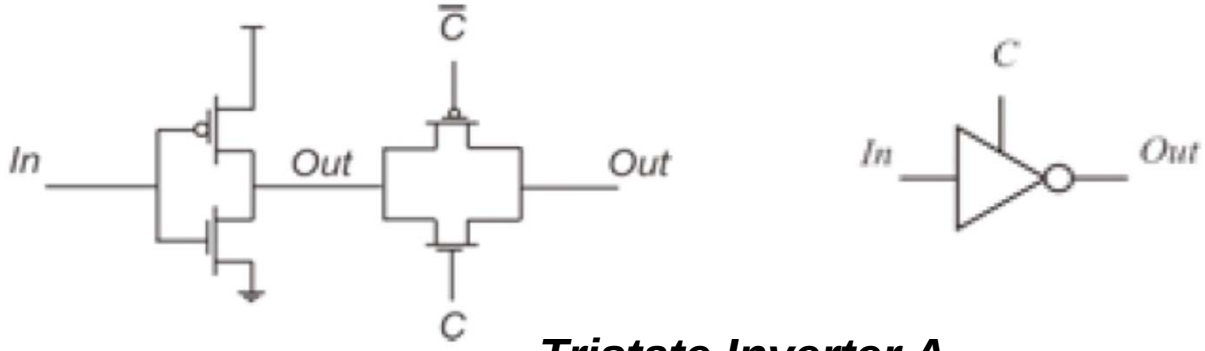
A	G	C
0	1	0
1	1	1
0	0	Z
1	0	Z

(b)

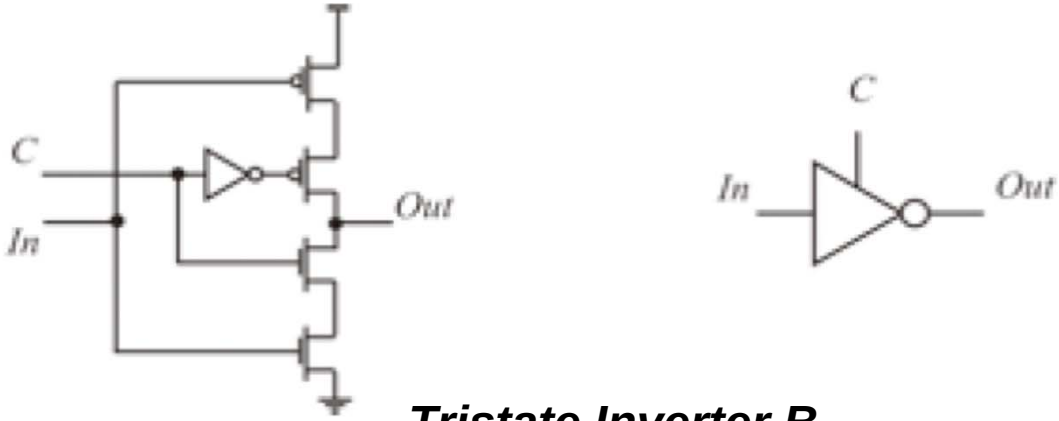


(c)

Tri-state CMOS Inverter



Tristate Inverter A

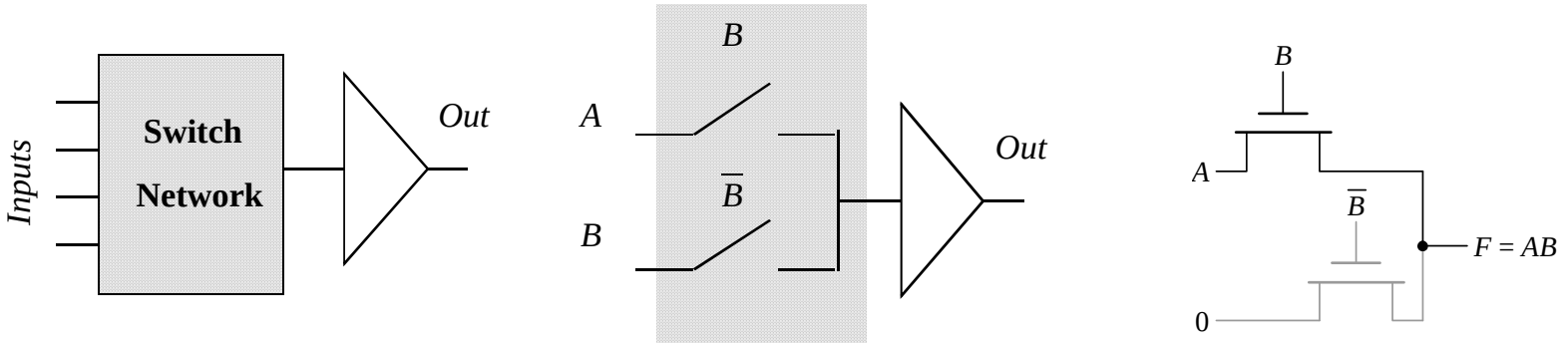


Tristate Inverter B

- **Which circuit, A, or B, is better to use?**

Complex Logic with Transmission Gates

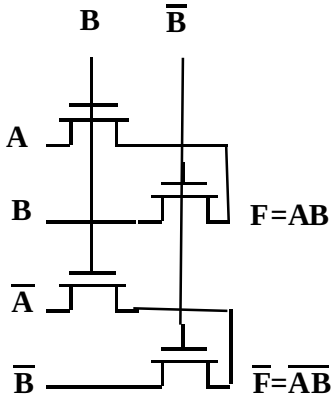
- Another way of reducing the number of transistors in complex logic gate is to use switch network.
- For instance AND gate can be implemented by only 4 transistors (instead of 6 transistor in CMOS implementation)



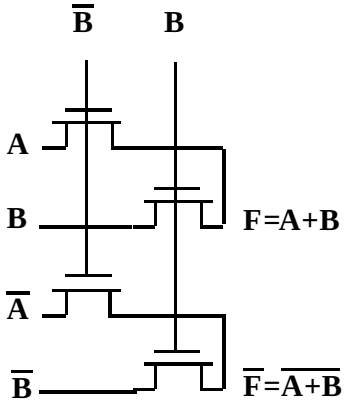
- N transistors
- No static consumption

Examples: Pass Transistor Networks

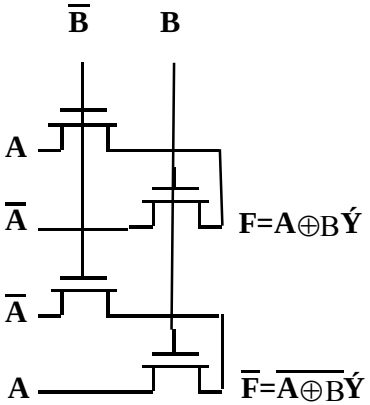
- Differential logics can be implemented using pass-transistor logic.
- These examples show that a complicated logic gate can be implemented with only few transistors



AND/NAND



OR/NOR



EXOR/NEXOR