CMOS Transistors

- Readings: B.1-B.3.1
- All circuit elements built from transistors
Transistor Switches

N-type

G=0
= open switch

G=1
= closed switch

P-type

G=0
= closed switch

G=1
= open switch

TRUE = 1 = 1.2 Volts
FALSE = 0 = 0 Volts

however:
0 —— good 0
1 —— poor 1

however:
0 —— poor 0
1 —— good 1
Using Transistor Switches

- Make a switch that transmits good 0 and 1?

- Transmission gate:
  
  ![Diagram of transmission gate]
Muliplexors

- How do we build a 2:1 Mux?

![Diagram of a 2:1 Mux]

<table>
<thead>
<tr>
<th>S</th>
<th>A</th>
<th>B</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>X</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Buses and Tristates:

- Can have more than one source of a signal

- Tristate:

- Bus:
  - Source 1
  - Source 2
  - Source 3
Basic Gates

Inverter

Nand Gate

Nor Gate:

Vdd (source of 1's)

GND (source of 0's)
Compound Gates

- A complex boolean function can be built from basic gates (inverter, NAND, NOR)

- Alternatively: \[ F = \overline{A + BC} \]
Compound Gates (cont.)

\[ F = A(BC + DE) \]
Memory

- A pair of inverters can hold a value:

- A value can be read, but how written?

- Alternative - DRAM: