Topic 3aux: Logic Design
A Ridiculously Brief Overview of Combinational Logic Design

- These slides provide a brief overview of combinational logic.
- They are limited to the ideas absolutely needed for the course.
- For a more detailed presentation consult Appendix C on the CD which comes with the course text.
Types of Logic Circuits

- *Combinational logic* is used to realize memoryless functions.

- *Sequential logic* is used to realize functions which have an internal state.

- These slides focus upon combinational logic.
Basic Gates

The AND gate

\[
\begin{array}{c|c|c|c}
A & B & C \\
0 & 0 & 0 \\
0 & 1 & 0 \\
1 & 0 & 0 \\
1 & 1 & 1 \\
\end{array}
\]

The OR gate

\[
\begin{array}{c|c|c|c}
A & B & C \\
0 & 0 & 0 \\
0 & 1 & 1 \\
1 & 0 & 1 \\
1 & 1 & 1 \\
\end{array}
\]

The Inverter

\[
\begin{array}{c|c}
A & B \\
0 & 1 \\
1 & 0 \\
\end{array}
\]

The Buffer

\[
\begin{array}{c|c}
A & B \\
0 & 0 \\
1 & 1 \\
\end{array}
\]
Further Gates

The NAND gate

A | B | C
---|---|---
0 | 0 | 1
0 | 1 | 1
1 | 0 | 1
1 | 1 | 0

The NOR gate

A | B | C
---|---|---
0 | 0 | 1
0 | 1 | 0
1 | 0 | 0
1 | 1 | 0

The XOR gate

A | B | C
---|---|---
0 | 0 | 0
0 | 1 | 1
1 | 0 | 1
1 | 1 | 0
Compact Representation of Negation

- Negation may be represented as a circle on another gate.

- The following two circuits are equivalent.

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<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
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\[ \text{A} \quad \text{B} \quad \text{C} \]
The Multiplexer

- A multiplexer selects between two (or more) inputs.
- S is the select line.
- Shown is a two-input multiplexer.
A One-Bit Half Adder

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A One-Bit Full Adder

<table>
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<th>B</th>
<th>C_in</th>
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A Sequential Adder

- An n-bit sequential adder may be realized by gluing n one-bit full adders together.
- This is not the best design because the critical path is proportional to n.