Today's topics

Computer Hardware
Electric Circuits

Upcoming
Computer Communications
   (Great Ideas Chapter 10)

Reading
   (not in text)

The Hardware Level

- Levels of a Computer System
  - Applications
  - Java
  - Machine Architecture/Assembler
  - Electric Circuits
- Circuits: Water Model
  - Reservoir
  - Pump
  - Paddle wheel/turbine
- Circuits: The real thing = electrons
  - Battery / generator
  - Heat -> Light
  - Motors

Expressing Logic in Circuits

- Circuits with switches (e.g. knife switch)
  - Use battery, switch, and light bulb

- Light, L, turns on when switch, X, is depressed
- For anything more complicated, we will use 3 notations
  - Truth Table
  - Circuit Diagram
  - Boolean Expression

Simple Logic

- Define the AND operator

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

- You should no how to get from one notation to another
  - I.e., given circuit, come up with table or expression
Simple Logic

- Define the OR operator

\[
\begin{array}{ccc}
X & Y & L \\
0 & 0 & 0 \\
0 & 1 & 1 \\
1 & 0 & 1 \\
1 & 1 & 1 \\
\end{array}
\]

\[L = X + Y\]

Circuit

You should know how to get from one notation to another
- I.e., given circuit, come up with table or expression

Simple Logic

- Define the NOT operator

\[
\begin{array}{cc}
X & L \\
0 & 1 \\
1 & 0 \\
\end{array}
\]

\[L = \overline{X}\]

Circuit

You should know how to get from one notation to another
- I.e., given circuit, come up with table or expression

More Complex Logic

- Some fairly arbitrary circuits shown on web page
- Deal with general 3 input circuit

Truth Table

\[
\begin{array}{cccc}
X & Y & Z & L \\
0 & 0 & 1 & 1 \\
0 & 1 & 1 & 1 \\
0 & 1 & 0 & 1 \\
0 & 1 & 1 & 0 \\
1 & 0 & 0 & 1 \\
1 & 0 & 1 & 0 \\
1 & 1 & 0 & 0 \\
1 & 1 & 1 & 1 \\
\end{array}
\]

What are the alternate forms?

Relays

- Relays are an electrically controlled switch
  - Uses electromagnet
  - May have several switches set by one magnet
    - (Shown with dotted line or “string” on diagrams)

- Look at several examples on web site
Designing a Relay Memory Element

- Web shows step by step sequence that leads to a bi-stable element
  - Called a latch
  - “Remembers” previous setting
  - Thus represents 1 bit of memory

Binary Numbers

- Table of binary (and decimal) numbers (continued)

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<td>1 1 1 1 1 5</td>
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