Digital Circuits and Systems

Spring 2015 Week 1 Module 2

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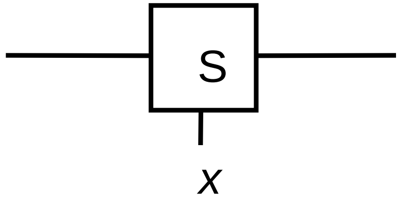
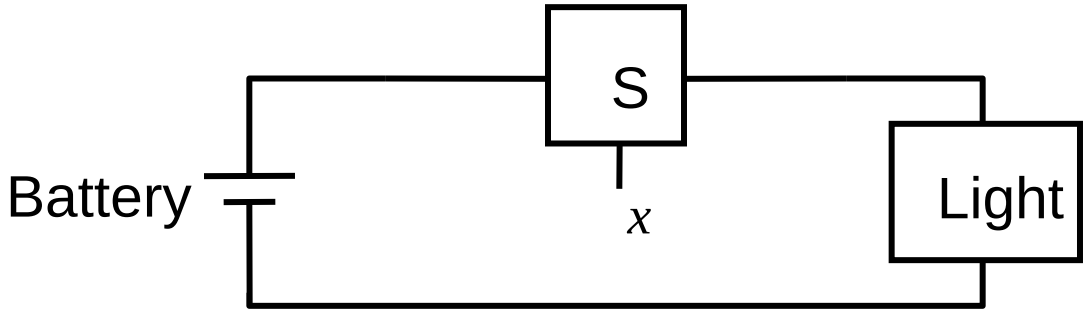
Binary Switch

(a) Two states of a switch



(b) Symbol for a switch

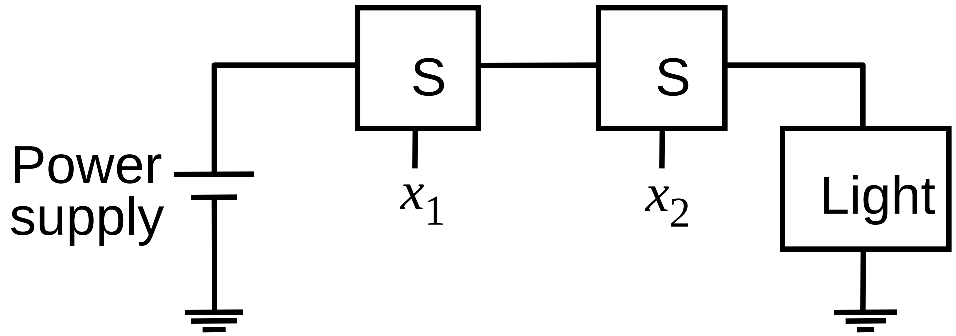
A Light Controlled by a Switch



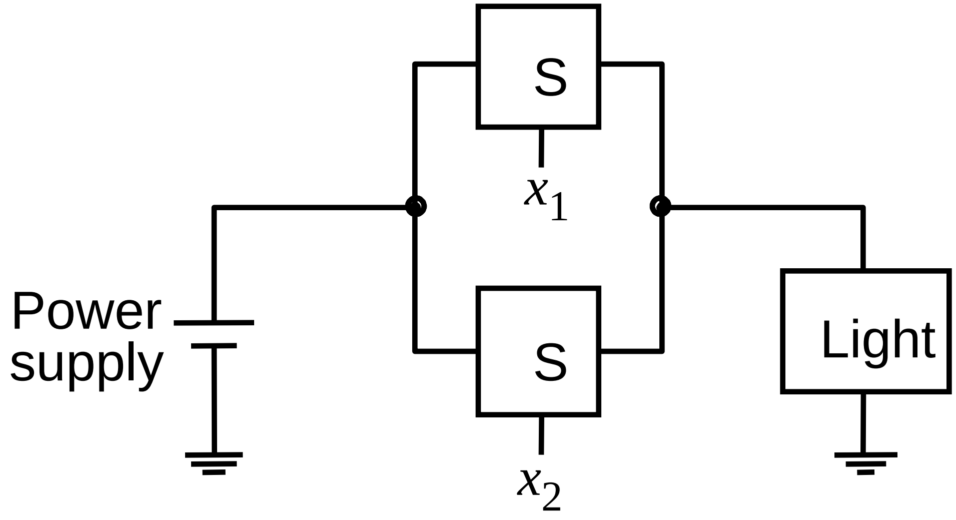
Simple connection to a battery

Two Basic Functions

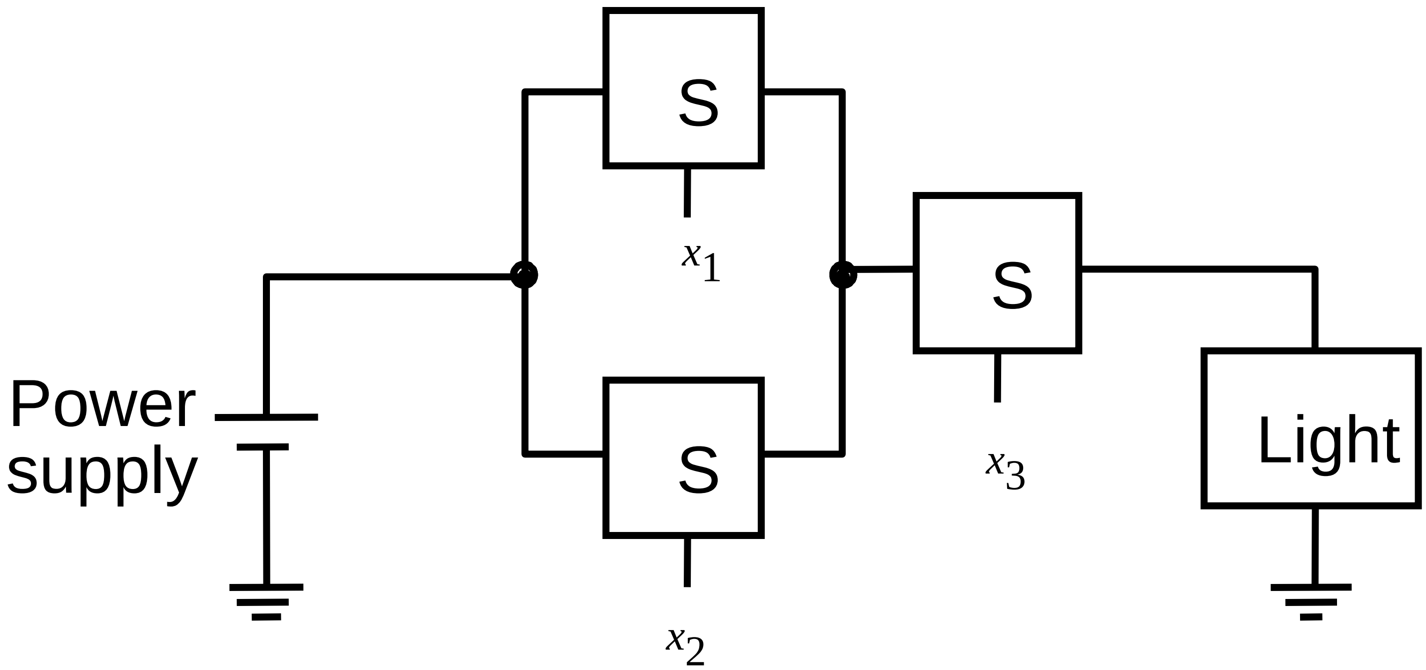
(a) The logical AND function (series connection)



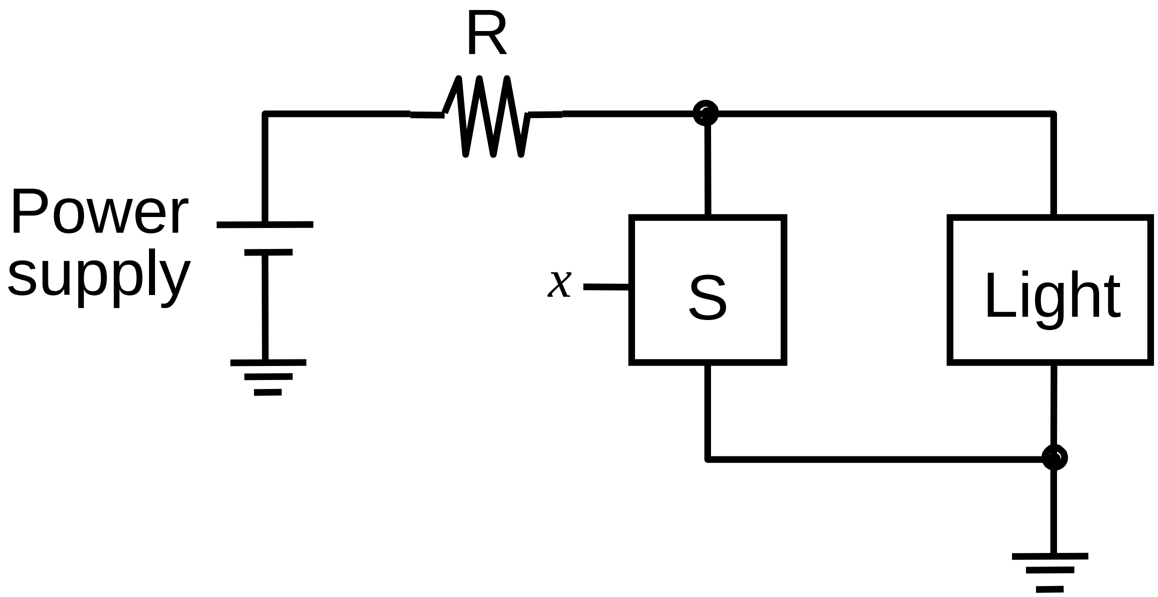
(b) The logical OR function (parallel connection)



A Series Parallel Circuit



An Inverting Circuit



Truth Table

x_1	x_2	$x_1 \bullet x_2$	$x_1 + x_2$
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	1
		AND	OR

Truth Table of 3-Input AND and OR Operations

x_1	x_2	x_3	$x_1 \bullet x_2 \bullet x_3$	$x_1 + x_2 + x_3$
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Truth Table of 3-Input AND and OR Operations

x_1	x_2	x_3	$x_1 \bullet x_2 \bullet x_3$	$x_1 + x_2 + x_3$
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

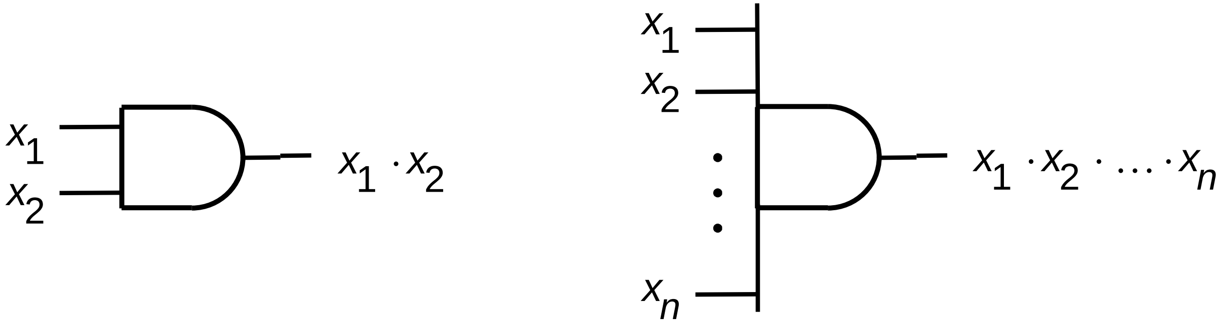
Symbols

- AND
  - Dot ($\bullet$)
  - Imagine it to be like multiplication
  - Example $x \bullet y$
  - Called “x and y”
- OR
  - Plus (+)
  - Imagine it to be like addition
  - Example $x + y$
  - Called “x or y”

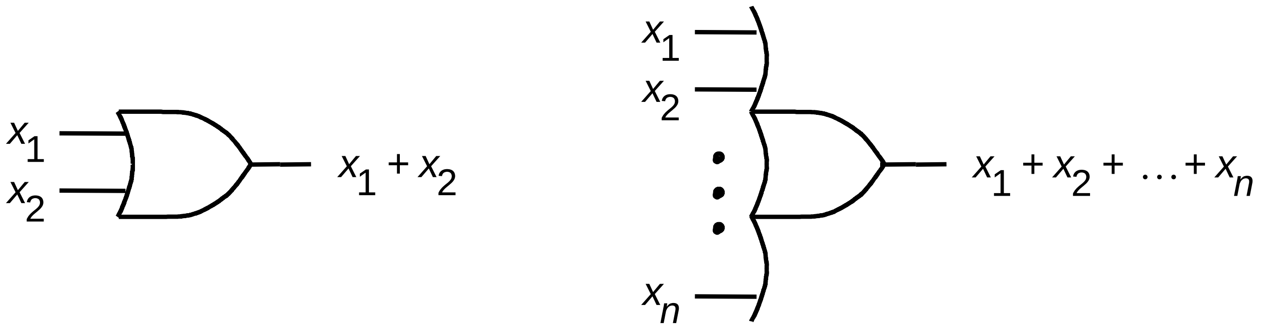
NOT Operation

- Symbol
  - Closing single quote ’
  - Also overline $\overline{\ }$ and ! symbol
  - Example: x', $\overline{x}$, $!x$
- Calling
  - x complement
  - “not of x”
  - Simpler: “x bar”

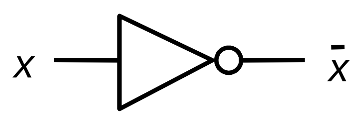
Symbols



(a) AND gates



(b) OR gates



(c) NOT gate

Boolean Algebra

- Named after George Boole
- Axioms
  - $0 \cdot 0 = 0$
  - $0 + 0 = 0$
  - $0' = 1$
- Duality
  - $1 \cdot 1 = 1$
  - $1 + 1 = 1$
  - $1' = 0$
- $0 + 1 = 1 + 0 = 1$
- $0 \cdot 1 = 1 \cdot 0 = 0$

Single Variable Theorems

- $x \cdot 0 = 0$
- $x + 1 = 1$
- $x \cdot 1 = x$
- $x + 0 = x$
- $x \cdot x = x$
- $x + x = x$
- $x + !x = 1$
- $x \cdot !x = 0$
- $x \cdot x \cdot x \cdot \ldots x = x$
- $!!x = x$

Two Variable Theorems

- $x \cdot y = y \cdot x$
- $x + y = y + x$
- Both are commutative

Three Variable Theorems

- Associative Laws
  - $x \cdot (y \cdot z) = (x \cdot y) \cdot z$
  - $x + (y + z) = (x + y) + z$
- Distributive Law
  - $x \cdot (y + z) = (x \cdot y) + (x \cdot z)$
- $x + (y \cdot z) = (x + y) \cdot (x + z)$
- More as we go

End of Week 1: Module 2

Thank You