

9/3/2009 outline

- 1) Reminder Recitation is Friday at 9^{AM}
- 2) Hand back Grade HW 1
- 3) HW 2 is posted online and is due Tuesday 9/8
- 4) Questions Regarding Number Conversions?
- 5) Sign Extension
- 6) Overflow w Addition > Rahul to discuss as well
- 7) Ch. 2 notes

Combinational Circuit

outputs depend on the present combination of inputs

Switches

CMOS - Complementary
metal
oxide
semiconductor

P type + N type

MOSFETS

metal

oxide

Semiconductor

Field

effect

Transistors

Basic Building Blocks

Boolean Algebra ← George Boole 1840's

AND

OR

NOT

Truth Tables

Sign Extend

$-30_{10} \rightarrow$ Binary 2's complement (10-bits)

$$\frac{30}{2} = 0$$

$$\frac{15}{2} = 1$$

$$\frac{7}{2} = 1$$

$$\frac{3}{2} = 1$$

$$\frac{1}{2} = 0$$

* \emptyset

$$\begin{array}{r} 11110_2 \\ \hline 0 \quad 1 \quad E \\ \hline 00000011110_2 \end{array}$$

$$\textcircled{1} \quad 1111100001$$

$$\textcircled{2} \quad + \quad \boxed{1111100010_2}$$

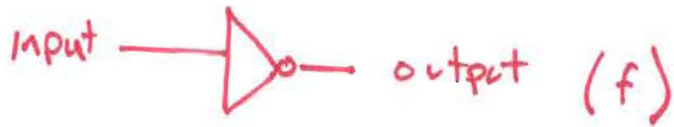
Invert bits
add 1

$$-2^9 +$$

+30

$$\begin{array}{r} \hline 111111111100010 \\ \hline \end{array}$$

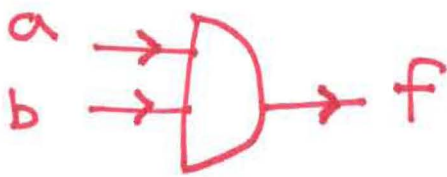
$$-2^{15}$$



Not Gate

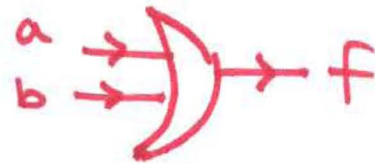
input	output
0	1
1	0

Truth Table



AND Gate

inputs		outputs
a	b	f
0	0	0
0	1	0
1	0	0
1	1	1



OR Gate

a	b	f
0	0	0
0	1	1
1	0	1
1	1	1

$f = 1$ when both inputs are 1

$f = 1$ when at least 1 input is 1

2 inputs (a, b) - 4 combinations

3 inputs (a, b, c) - 8 combinations

a	b	c	F	B AND C
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

n # inputs

2^n combinations

$$F = A \text{ OR } (B \text{ AND } C)$$

↑ ↑ ↑
③ ① ②

A=1
B=0
C=1

B AND C

0 AND 1 = 0

A OR \emptyset = 1

$$f = (A \text{ AND } B) \text{ OR } (C \text{ AND } D)$$

$$4 \text{ inputs} = 2^4 = 16$$

A	B	C	D	(A AND B)	(C AND D)	F
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	0	1	1	0	1	1
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	0	1	1
0	1	1	1	0	1	1
1	0	0	0	0	0	0
1	0	0	1	0	0	0
1	0	1	0	0	0	0
1	0	1	1	0	1	1
1	1	0	0	1	0	1
1	1	0	1	1	0	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1