Quiz: thursday

RCH 302 2:30-3:30 3 questions (up to full adders)

F2002 21, 22, 23, 24a, bonus
F2008 21ab, 22, 23, 24, 25, Q7
W2012 Q1ab, Q2, Q3, Q5bc
W2013 Q1ab, Q2, Q3, Q5

Common Combinational Circuits.

Concept: Complex circuits can be built from smaller, fundamental building blocks.

Objectives: Introduce some of these building blocks
- Comparator
- Multiplexer

Implement a comparator circuit from its algorithm (common theme in circuit design)

Comparator: - compares 2 n-bit unsigned numbers.
- Return Equality (E) Greater Than (GT)
① A=B ② A>B

Less Than (LT)
③ A<B

Equality (E): $A = a_{n-1} a_{n-2} \dots a_1 a_0$ $a_i = b_i$
A=B $B = b_{n-1} b_{n-2} \dots b_1 b_0$

If $a_i = b_i$ for each $i = n-1 \ldots 0$

then $A = B$

Truth Table

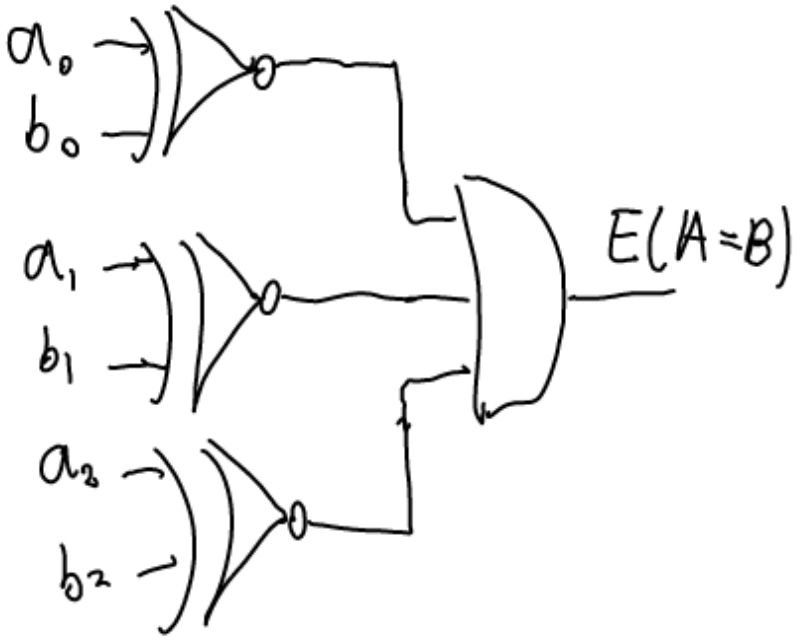
a_i	b_i	e_i
0	0	1
0	1	0
1	0	0
1	1	1

$e_i = \bar{a}_i \bar{b}_i + a_i b_i$

$= a_i \odot b_i$

For Equality $E = e_{n-1} e_{n-2} \ldots e_1 e_0$

3-bit Gate Level Implementation



Greater Than (GT)

$A > B$

$(100)_2 > (111)_2$

$2^2 \quad 2^1 + 2^0$

For $i = n-1 \ldots 0$ {

if $(a_i > b_i)$ {A>B}

else if $(a_i < b_i)$ {A<B}

if $(i == 0)$ {A=B}

}

a_i	b_i	e_i	gt	Lt
0	0	1	0	0
0	1	0	0	1
1	0	0	1	0
1	1	1	0	0

SOP $\quad a_i \bar{b}_i \quad \bar{a}_i b_i$

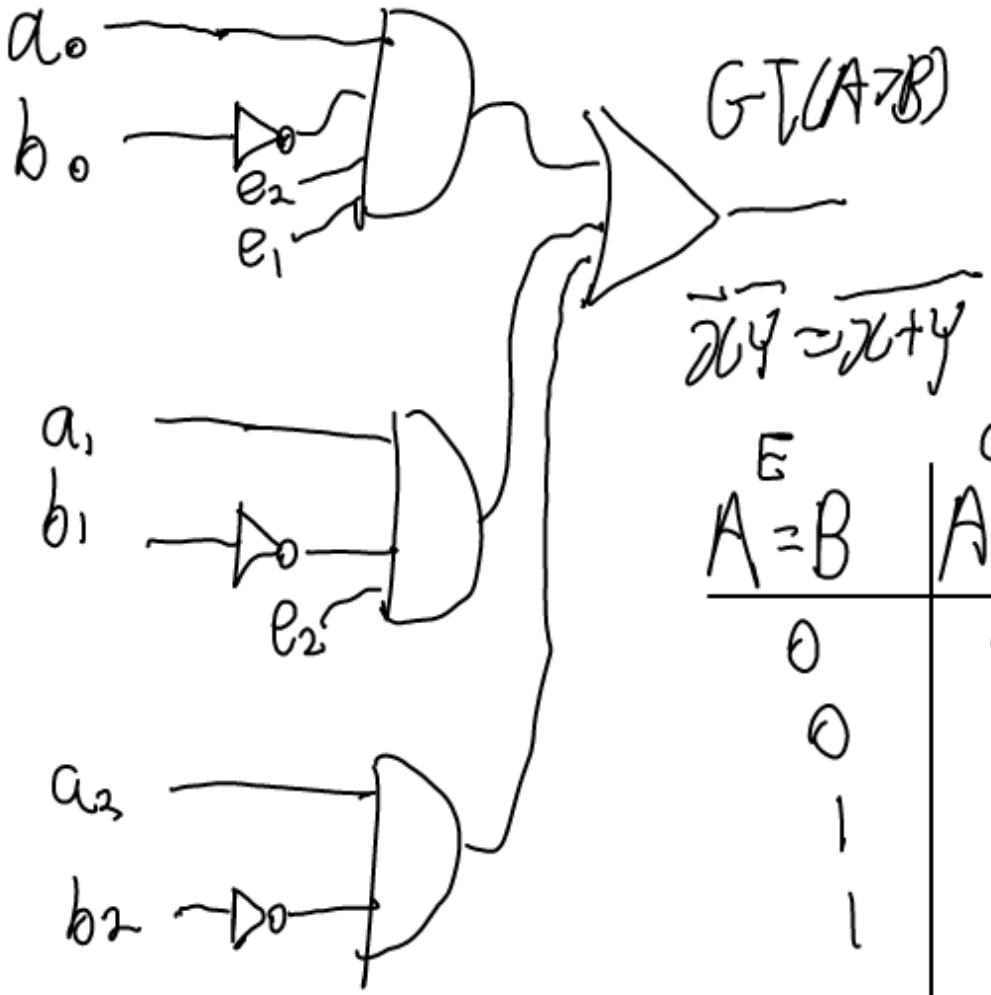
SOP for $A>B$

$$GT = a_{n-1}\bar{b}_{n-1} + e_{n-1}a_{n-2}\bar{b}_{n-2} + \dots + (e_{n-1}e_{n-2}\cdots e_1)(a_0\bar{b}_0)$$

3 bit Implementation

$A > B$

LSB



$\overline{xy} = \bar{x} + \bar{y}$

E	GT	LT
A=B	A>B	A<B
0	0	1
0	1	0
1	0	0
1	1	X

$$LT = \bar{E}\,\bar{GT}$$

$$= \overline{E + GT}$$

$$= E \text{ NOR } GT$$

Consider subtraction $A-B$.

If $A-B=0$ E

$A-B>0$ GT

$A-B<0$ LT

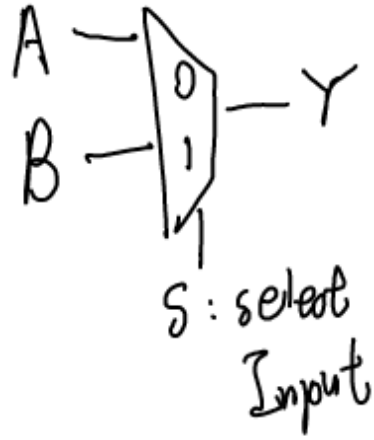
good example

5.10 p307-309

Multiplexer (MUX)

Data is passed to the output based on the state of select signal(s).

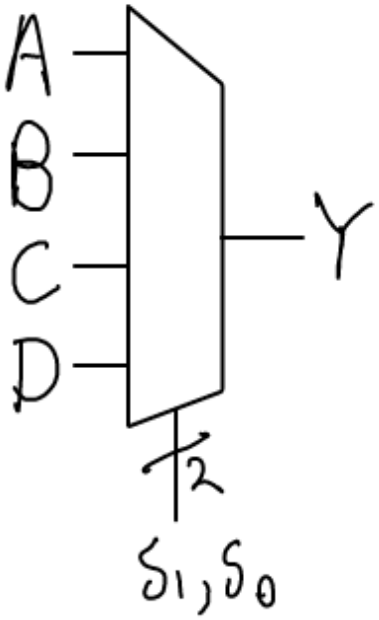
Data Inputs

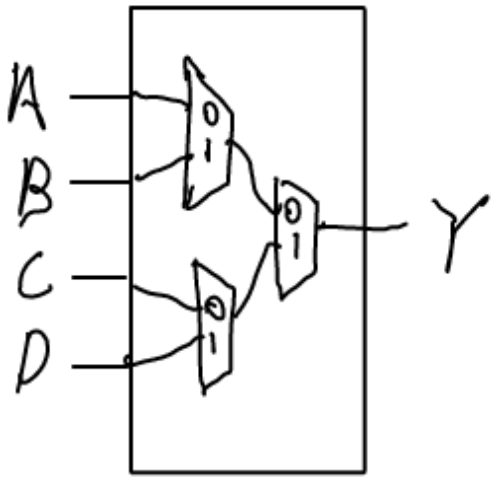


Output

S	Y
0	A
1	B

4-input mux





S_1	S_0	Y
0	0	A
0	1	B
1	0	C
1	1	D