Computer Systems

Lecture 04: Gates, Boolean Arithmetic, Sequential Logic

Review and Exercises

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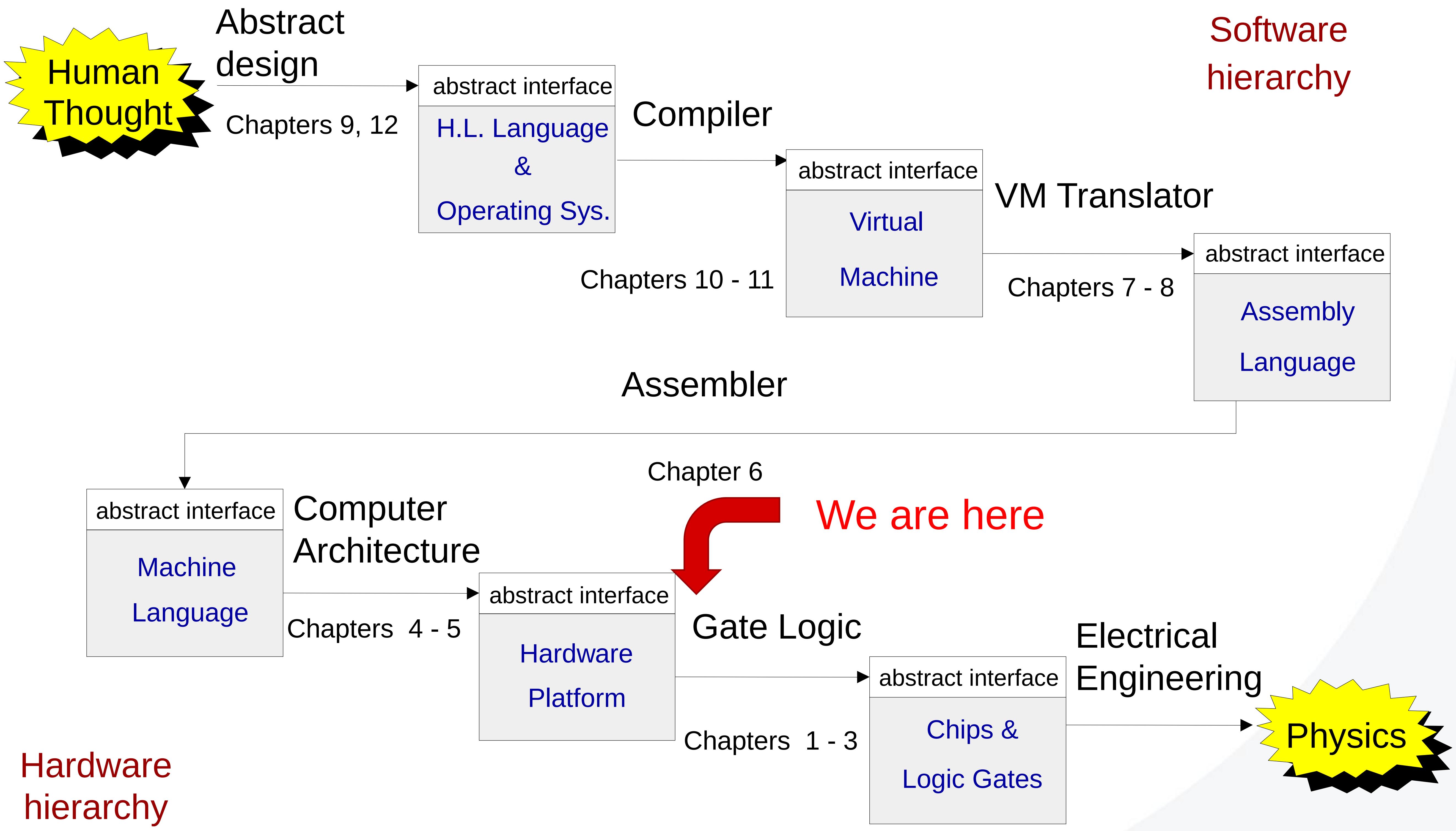
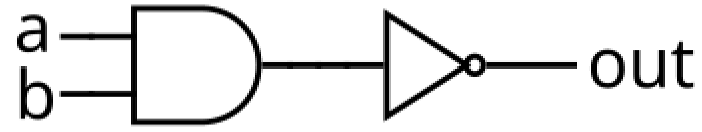
Our Journey

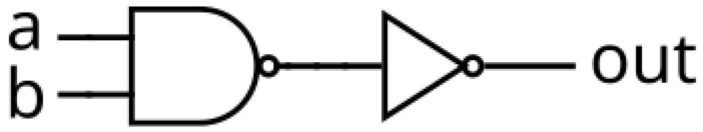


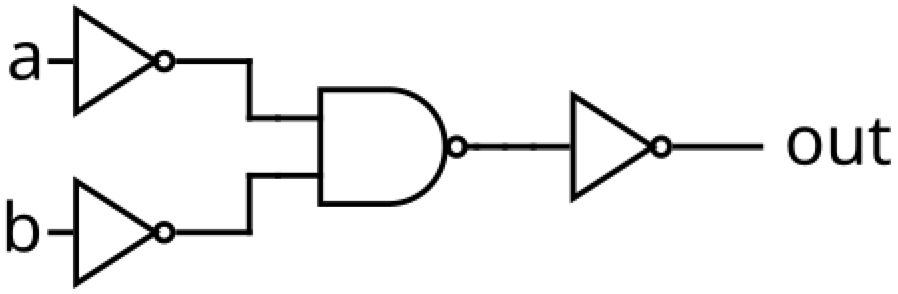
(Abstraction–implementation paradigm)

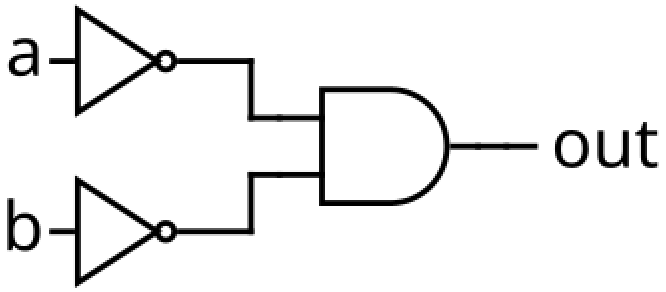
Quiz questions 1

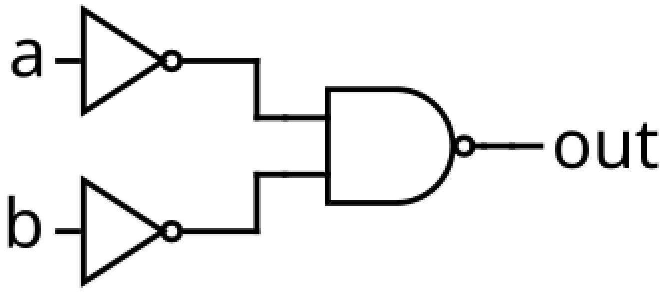
Which of the following logic circuits is equivalent to an OR gate?

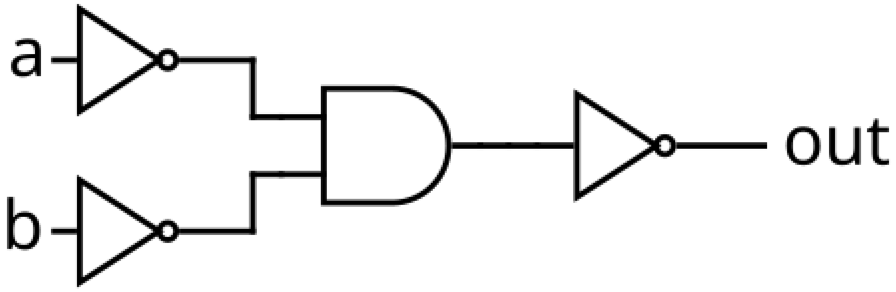












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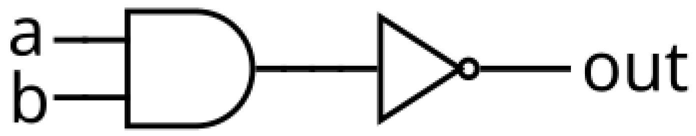

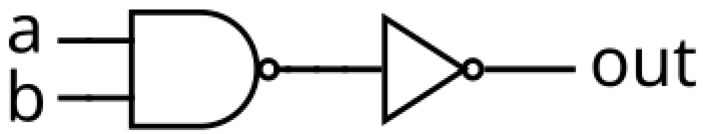

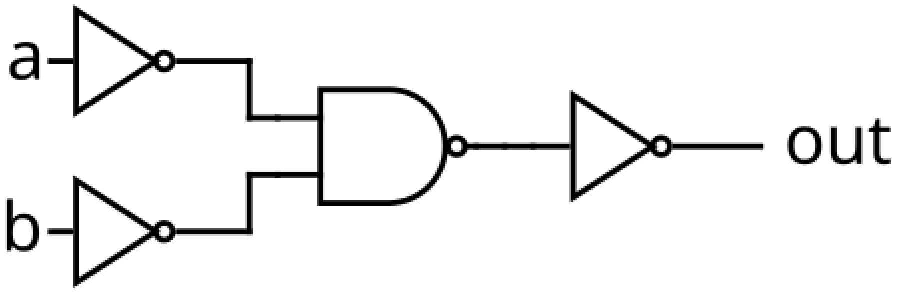

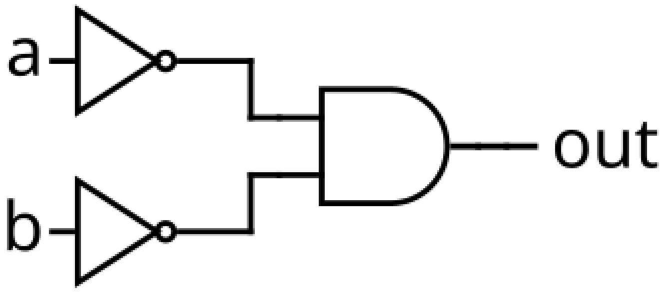

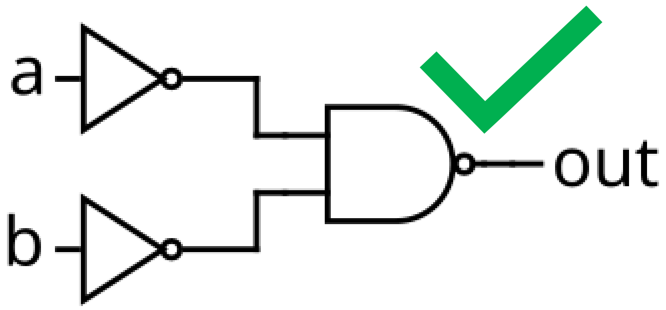

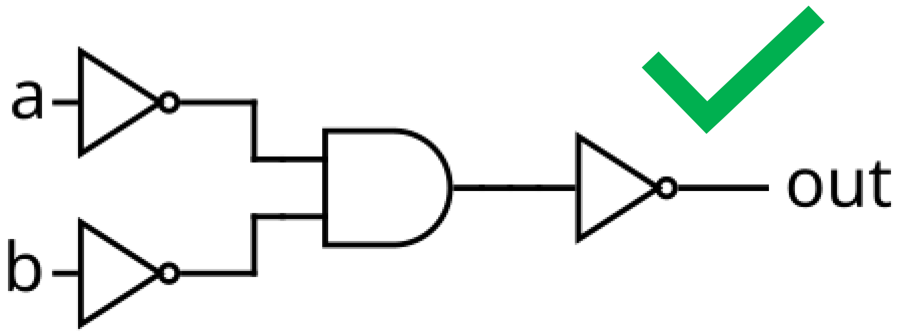

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Quiz questions 2

Why do we use two's complement to represent negative numbers in binary?

- ❑ **So that we can perform addition without worrying about the sign of the numbers**
- ❑ **So that there is only one representation of 0**
- ❑ **So that we can use the most significant bit as a sign bit**

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Quiz questions 3

Consider the following diagram for a DMUX, where the unselected output wires are set to zero.Would a DMux still be a useful chip if these values were always set to 1?

- No. It would render the DMux useless because all of the rest of the machine would be expecting a zero in this place rather than a one and there is nothing we could do to fix it.
- Yes. You might have to invert this signal or change the expected interpretation of this signal.
- No. The ones make the output of the DMux unpredictable.
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Quiz questions 4

Which of the following statements about the HDL language used in this course are true.

- ❑ **HDL is a programming language**
- ❑ **HDL keywords are written in lowercase letters**
- ❑ **A chip definition consists of a header and a body. The header specifies the chip interface and the body its implementation.**
- ❑ **Names of chips and pins may be any sequence of letters and digits not starting with a digit.**

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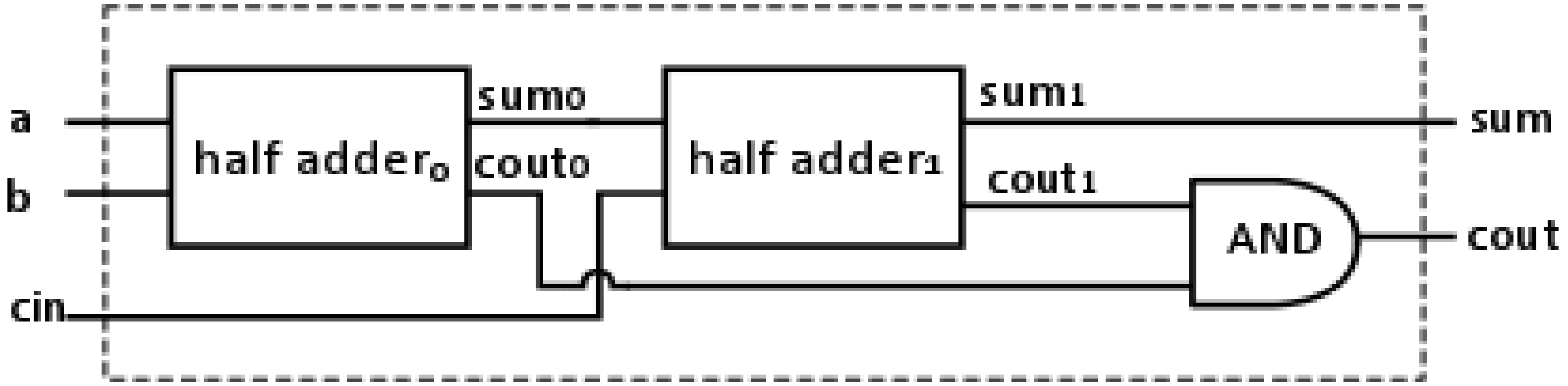
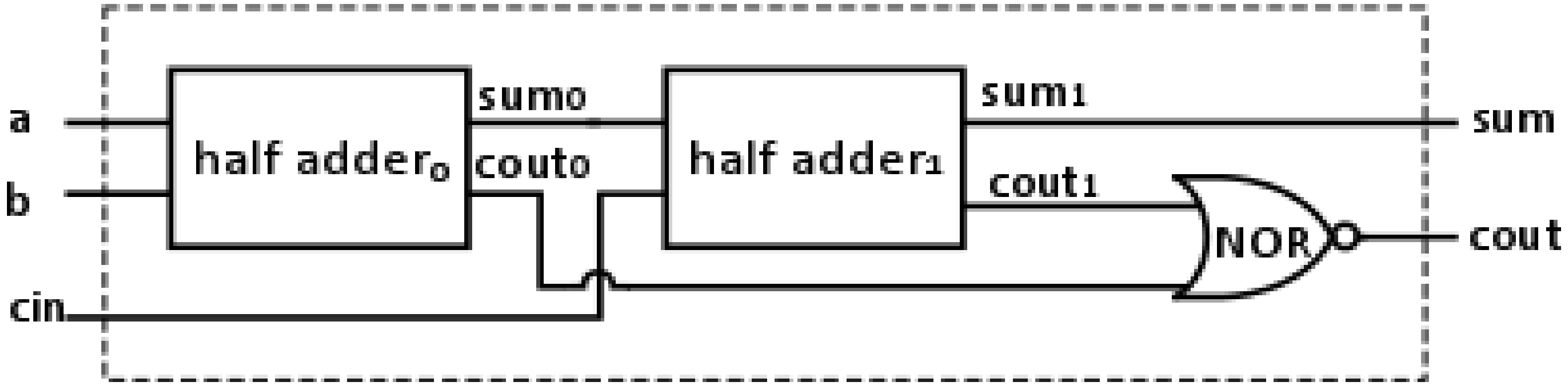
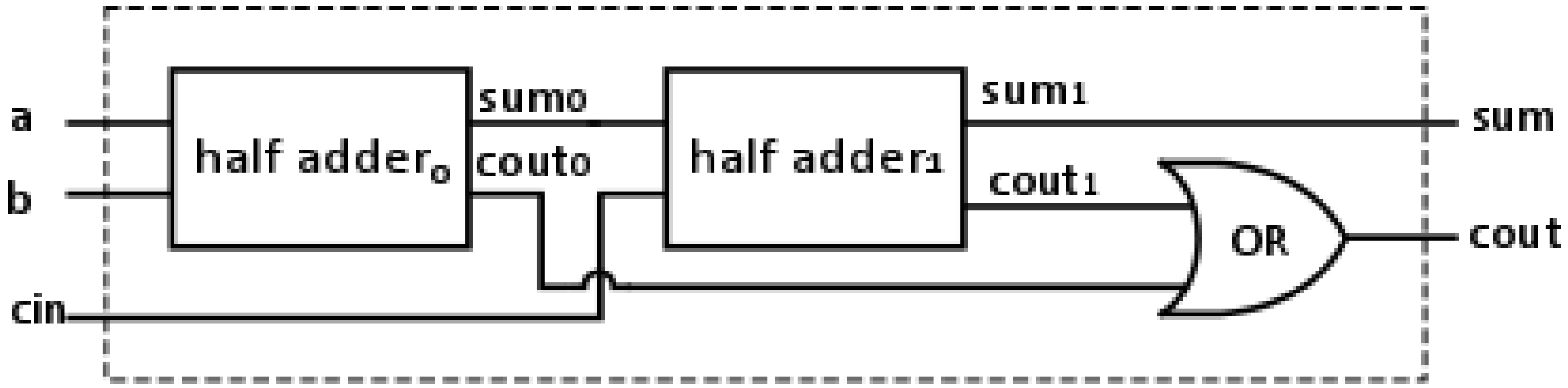
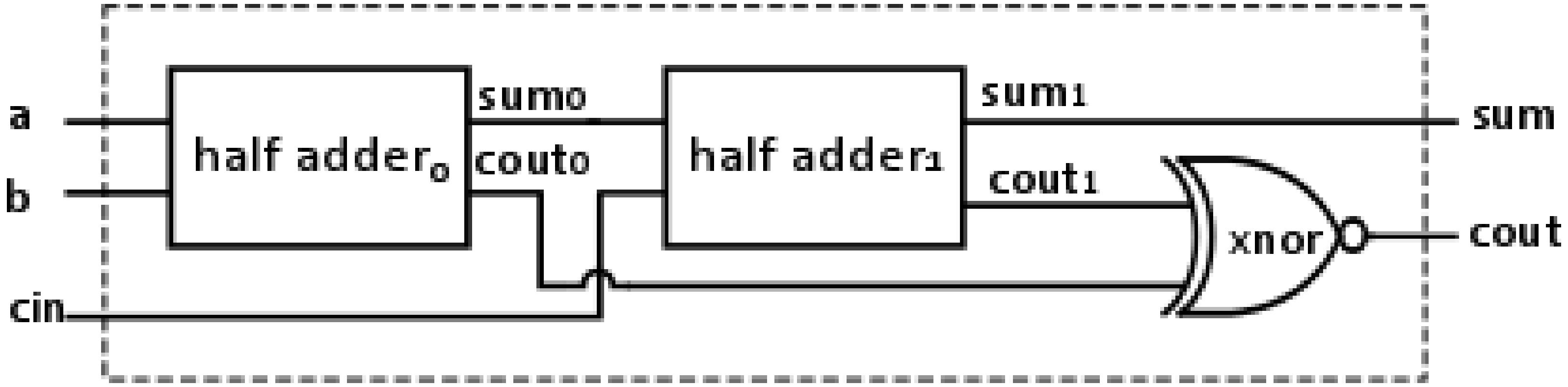
Quiz questions 5

Implementing a full adder using half adders.









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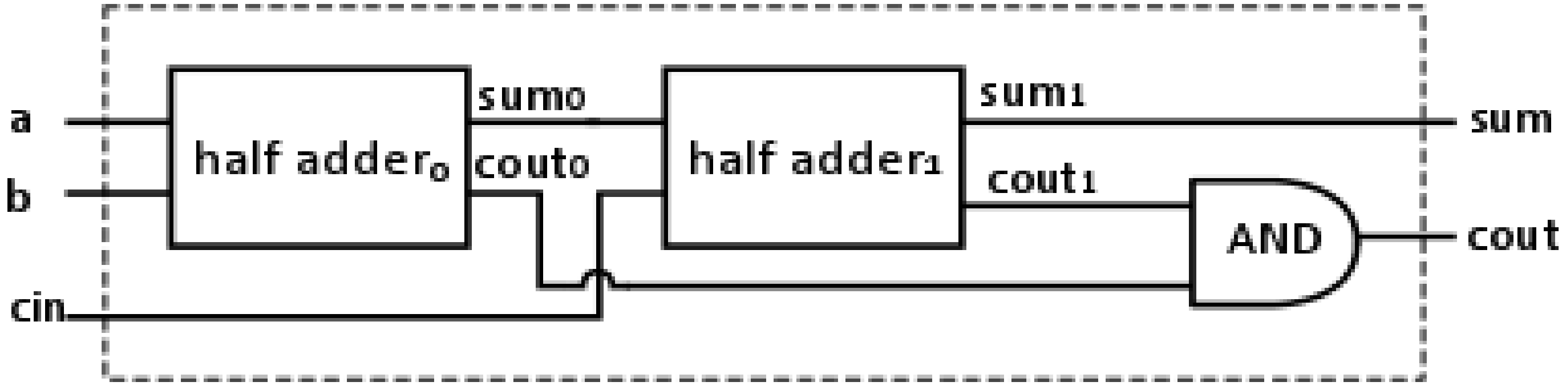

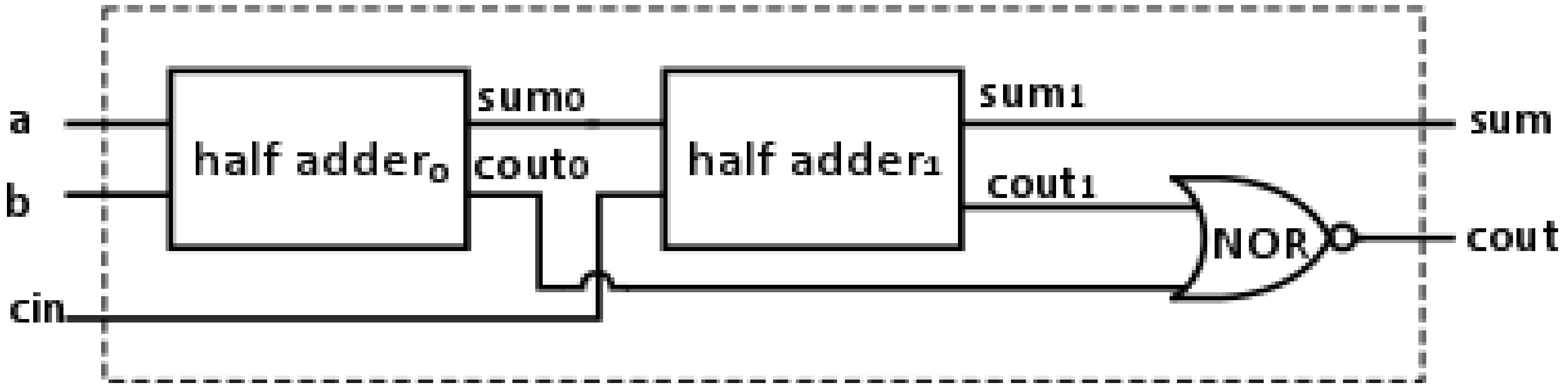

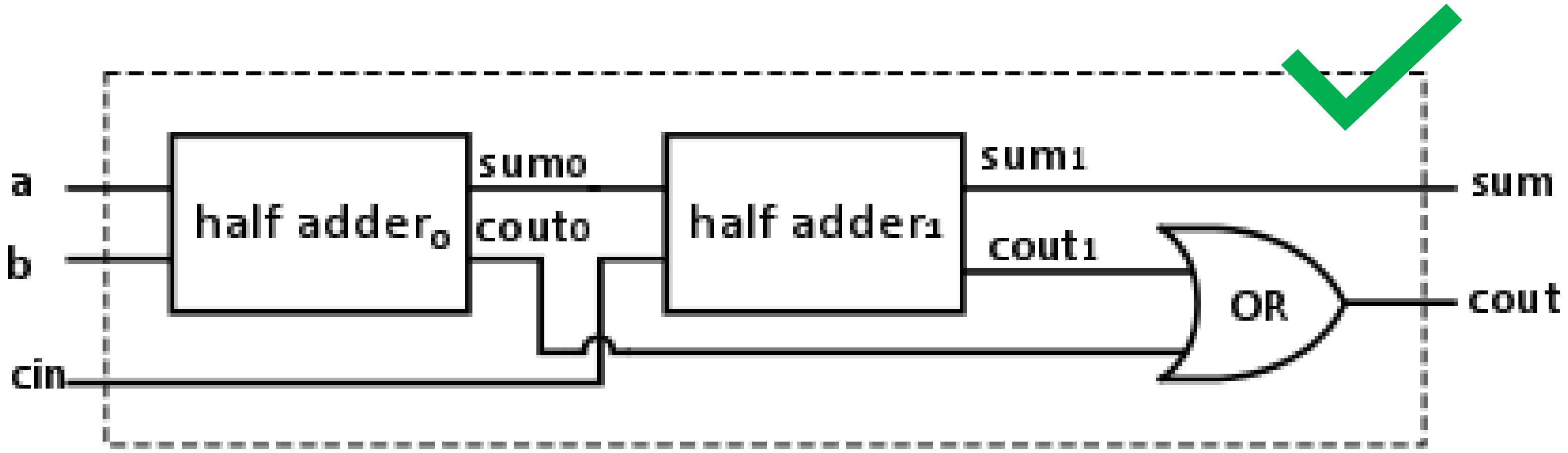

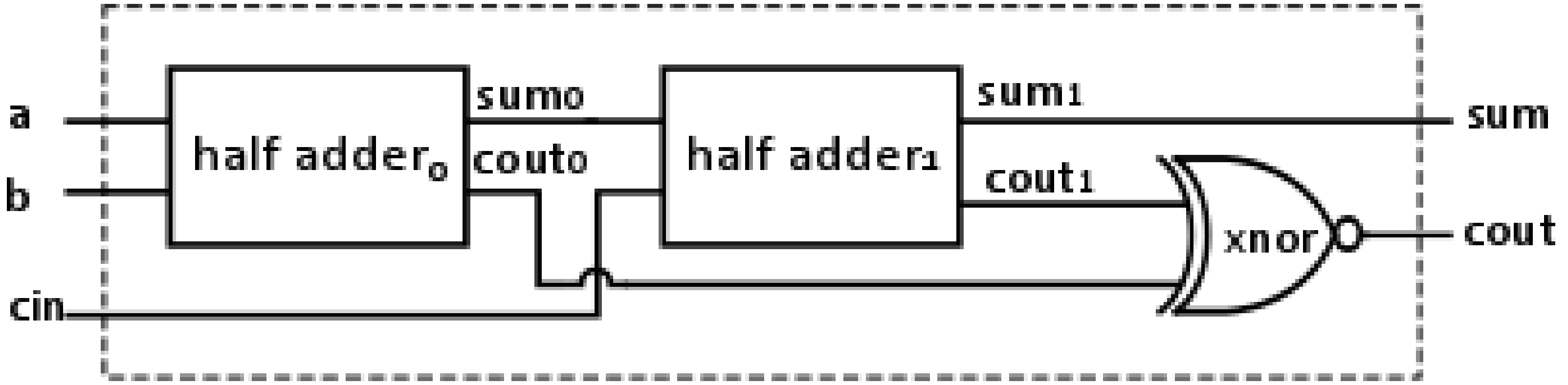

Exercise: 6-bit Two's Complement 101010 to decimal

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digits	1	0	1	0	1	0
weights	-2^5	2^4	2^3	2^2	2^1	2^0

$$= 1 * (-2^5) + 0 * 2^4 + 1 * 2^3 + 0 * 2^2 + 1 * 2^1 + 0 * 2^0$$
$$= -32 + 0 + 8 + 0 + 2 + 0$$
$$= -22$$

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Exercise: -125 to 8-bit Two’s complement

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Consider 125 first

2	125	1	LSB
2	62	0	
2	31	1	
2	15	1	
2	7	1	
2	3	1	
	1		

MSB

$125_{10} = 0111\ 1101_2$

$-125_{10} = 1000\ 0010_2 + 1_2$

$= 1000\ 0011_2$

Exercise: 4-bit Two's Complement -5 + -5

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Exercise: 4-bit Two's Complement -5 + -5

$5_{10} = 0101_2$

$-5_{10} = 1010_2 + 1_2$

$-5_{10} = 1011_2$

$$
\begin{array}{rccccc}
 & & 1 & 0 & 1 & 1 \\
+ & & 1 & 0 & 1 & 1 \\
 & 1 & 0 & 1 & 1 & \\
\hline
 & 1 & 0 & 1 & 1 & 0
\end{array}
$$

$0110_2 = 6_{10}$

Exercise: 16-bit Unsigned 32760 + 8

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Will this overflow?

What is the largest 16-bit unsigned?

$$2^n - 1$$
$$= 2^{16} - 1$$
$$= 65536 > 32760$$

No overflow, so 32768 +8 = 32768.

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Exercise: Write logic equation and truth table based on circuit diagram

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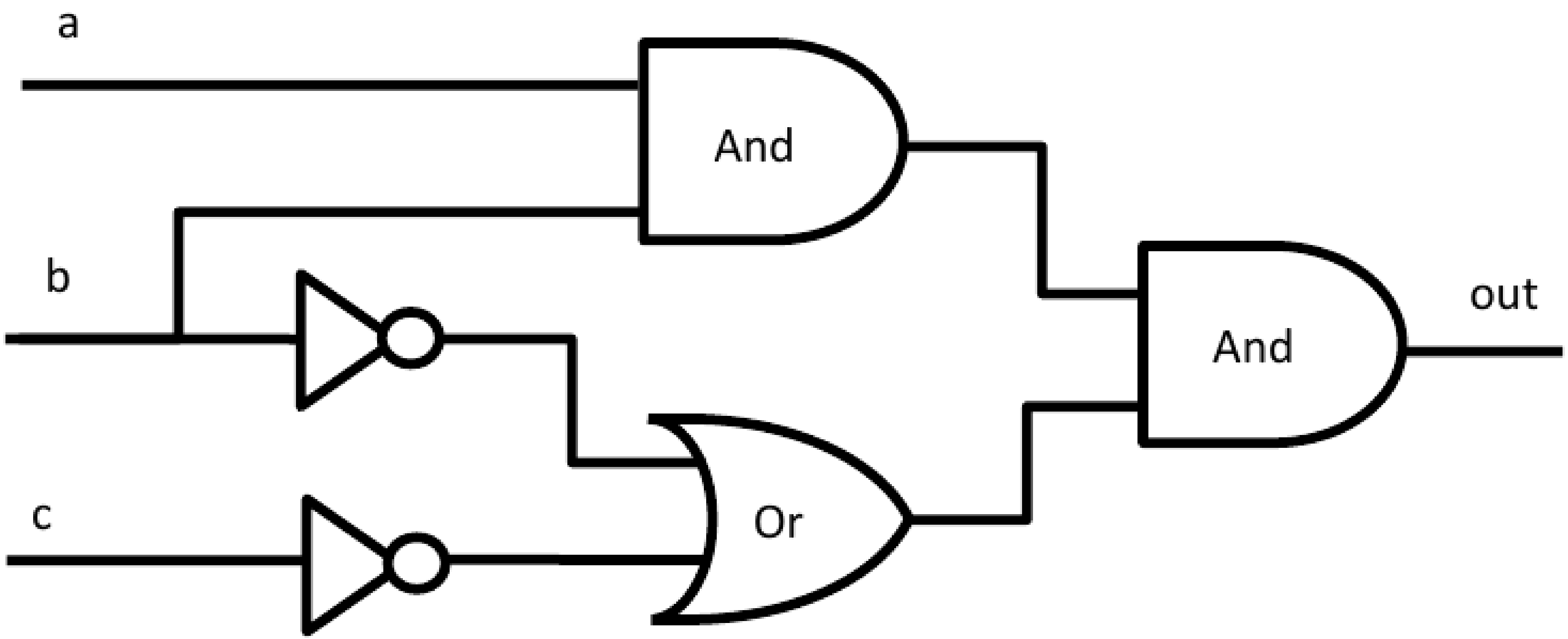

a	b	c	out
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

$$
\begin{aligned}
out &= (a \cdot b) \cdot \left(\bar{b} + \bar{c}\right) \\
&= a \cdot b \cdot \bar{b} + a \cdot b \cdot \bar{c} \\
&= 0 + a \cdot b \cdot \bar{c} \\
&= \; a \cdot b \cdot \bar{c}
\end{aligned}
$$

Exercise: For a given truth table, write the logic equation and draw circuit diagram.

a	b	c	out
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

This Week

- Review Chapters 2 & 3 of the Text Book (if you haven’t already)
- Finish Assignment 1 (due Friday)
- Review Chapter 4 of the Text Book before next week.