Computer Systems and Networks

ECPE 170 – Jeff Shafer – University of the Pacific

Exam 1 Review

Exam 1 Basics

- **Topics**
  - Chapter 2
    - Data representations
  - Chapter 3
    - Digital logic
  - *Part of* Chapter 4
    - Basic organization and memory systems
    - Nothing on MARIE

- **Rules**
  - No calculators
  - Closed book / notes / friend / Internet / etc…

Review Materials

- Things to study
  - Homework assignments
    - **Solutions are posted in Sakai**
  - Quiz 1 and 2
    - **Solutions are posted in Sakai**
  - Lecture notes
- Question format will be similar to quizzes
  - Mix of problems and short answer questions
  - *Problems typically come from textbook…*
  - *Short answer questions typically come from lectures…*

Chapter 2 – Data Representation

Number Formats

- **Convert 26.78125_{10} to binary (max of 6 digits after binary point)**

- Ans: 11010.11001

Number Formats

- **Convert 110010011101_2 to hexadecimal**

- Ans: $C9D_{16}$

Number Formats

- **Express 23_{10} and -9_{10} in 8-bit binary using signed-magnitude, 1’s complement, and 2’s complement format**
- Ans for 23:
  - Signed-magnitude: 00010111_2
  - One’s comp: 00010111_2
  - Two’s comp: 00010111_2
- Ans for -9
  - Signed-magnitude: 10001001_2
  - One’s comp: 11110110_2
  - Two’s comp: 11110111_2

Number Formats

- **Convert 26.78125_{10} to IEEE 754 single-precision floating-point format**
  (recall that 26.78125_{10} = 11010.11001)
- Ans:
  - Sign bit: 0 (i.e. positive)
  - Exponent: 10000011 (i.e. 127+4=131)
  - Significand: 1010110010….0 (for 23 bits)

Data Representation

- What is ASCII? EBCDIC? Unicode?
  - What do they do the same? Different?
  - Why are there three standards?

Chapter 3 – Digital Logic

Boolean Expressions

- **In the Boolean expression F(x,y)=x+y, does this mean "add the value to x to the value of y?"**
  - No: the + operator is OR!
- **Order of operations: what do I do first? Second?**

$$F(x,y,z) = \overline{xyz}$$

  - Equivalent way to write it:

$$F(x,y,z) = (xyz)'$$

Boolean Expression

- **Simplify the following Boolean expression:**

$$F(x,y,z) = xy + \overline{x}z + yz$$

$$F(x,y,z) = xy + \overline{x}z + (x + \overline{x})yz$$

$$F(x,y,z) = xy + \overline{x}z + xyz + \overline{x}yz$$

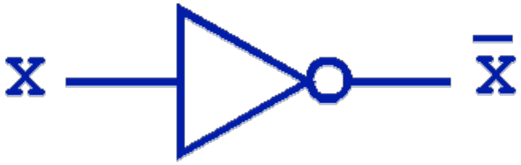
$$F(x,y,z) = xy + xyz + \overline{x}z + \overline{x}yz$$

$$F(x,y,z) = xy(1 + z) + \overline{x}z(1 + y)$$

$$F(x,y,z) = xy + \overline{x}z$$

Digital Logic

- **What is this gate?**
- **What is its truth table?**



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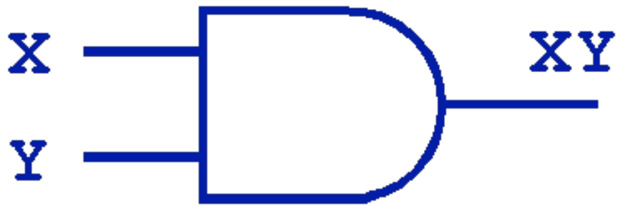

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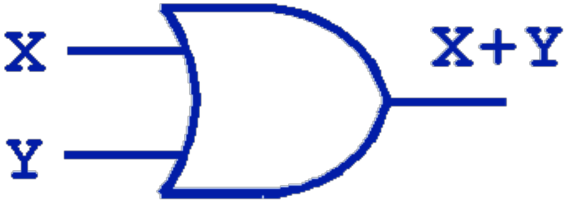

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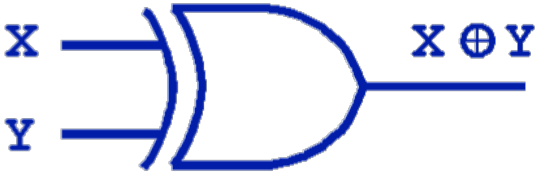

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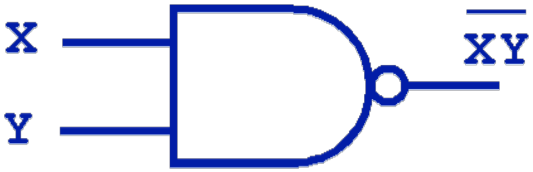

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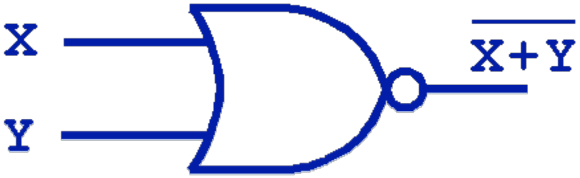
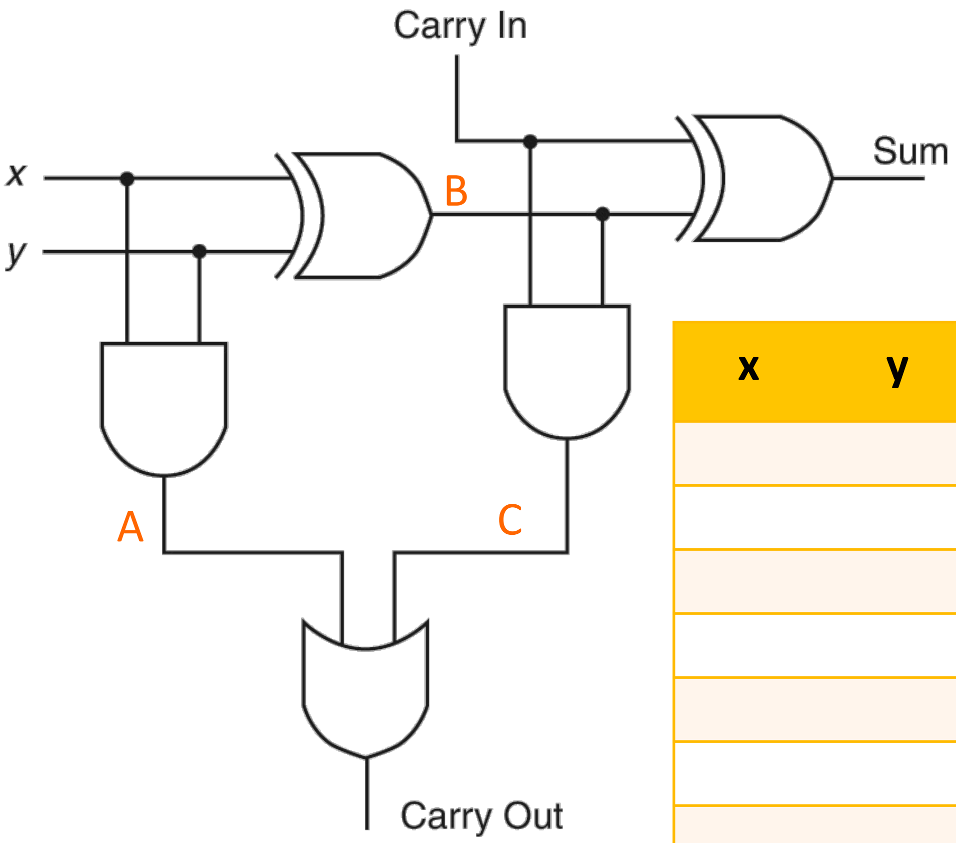


Digital Logic



- **Draw the truth table for this circuit**
  - **What is this circuit?**

x	y	Cin	A	B	C	Sum	Cout

Digital Logic – Sequential

- Give the truth table for an SR, JK, and D flip flop
  - What does SR mean?
  - What does JK mean?
  - What does D mean?

Karnaugh Maps

w	x	y	z	F
0	0	0	0	**1**
0	0	0	1	**0**
0	0	1	0	**0**
0	0	1	1	**1**
0	1	0	0	**0**
0	1	0	1	**1**
0	1	1	0	**0**
0	1	1	1	**1**
1	0	0	0	**0**
1	0	0	1	**0**
1	0	1	0	**1**
1	0	1	1	**1**
1	1	0	0	**0**
1	1	0	1	**1**
1	1	1	0	**0**
1	1	1	1	**1**

- **Construct a K-map from the truth table**
- **Simplify the resulting function**

$F(w,x,y,z) = yz+xz+w'x'y'z'+wx'y$

Chapter 4 – Computer Organization

Measures of Capacity and Speed

- **What do these prefixes mean in powers of 2 and 10? (Kilo, Mega, Giga, Tera, Peta)**
  - Kilo - (K) = 10^3 and 2^{10}
  - Mega - (M) = 10^6 and 2^{20}
  - Giga - (G) = 10^9 and 2^{30}
  - Tera - (T) = 10^{12} and 2^{40}
  - Peta - (P) = 10^{15} and 2^{50}
- **Which base do I use – powers of 2 or \10?**
  - **4 GB main memory**
    - Powers of 2
  - **58.9 PFLOP** (58 peta floating-point operations per second)
    - Sum of all the world's top supercomputers in June 2011
    - Powers 10

Computer Organization

- **What is a bus?**
- **What's the difference between a *point-to-point* and *multi-point* bus?**
- **What does the *clock* do?**
- **Is increasing the clock rate the only way to improve application performance?**

$$\text{CPU Time} = \frac{\text{seconds}}{\text{program}} = \frac{\text{instructions}}{\text{program}} * \frac{\text{avg.cycles}}{\text{instruction}} * \frac{\text{seconds}}{\text{cycle}}$$

Reduce any of these, or all three!

Computer Organization

- **What does *addressability* mean in the context of a memory system?**
- **Which type of memory system would require more address lines: a *word-addressable* memory, or a *byte-addressable* memory?**
- **What is the difference between *high-order* and *low-order* interleaving? (What is interleaving?)**

Memory Organization

- Exercise: Build a 1M x 16 word-addressable main memory using 128K x 4 RAM chips.

1. **How many address bits are needed per RAM chip?**
2. **How many RAM chips are there per word?**
3. **How many RAM chips are necessary?**
4. **How many address bits are needed for all memory?**
5. **How many address bits would be needed if it were byte addressable?**
6. **How many banks will there be?**
7. **What bank would contain address 47129_{16} with (a) high-order interleaving or (b) low-order interleaving?**

Solution to Exercise

1. Each RAM chip has 128K locations: $2^7 * 2^{10}$ = **17 bits**
2. Each RAM chip location stores 4 bits, but we need 16:
   1. **4 chips needed per word**
3. Each RAM chip has 128K locations, but we need 1M locations:
   1. 1M/128K = 8 (times 4 chips per word) = **32 RAM chips** (8 rows, 4 columns)
4. Memory is 1M: 2^20 = **20 bits for all of memory**
5. Byte addressable adds 1 more bit here (to select either the lower 8 or upper 8 of the 16 bit long word): **21 bits**
6. **8 banks** of memory, where each bank has 4 chips
7. Address is 20 bits long, bank is upper 3 bits (2^3=8):
   47129(16) = 0100 0111 0001 0010 1001 (2)
   With high-order interleaving, bank is **#2**
   With low-order interleaving, bank is **#1**