

<b>Name:</b> (as it would appear on official course roster)	Erwan Fraisse	
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<b>Lab Section Time:</b> Friday at 12:00 P.M.		
<b>Optional:</b> name you wish to be called if different from above -----		
<b>Optional:</b> name of "homework buddy" (leaving this blank signifies "I worked alone") -----		

## Lab 01: Data Representation and Binary Arithmetic

**Assigned:** Wednesday, October 2<sup>nd</sup>, 2019

**Due:** Wednesday, October 9<sup>th</sup>, 2019

**Points:** 30 (normalized to 100)

- You may collaborate on this homework with AT MOST one person, an optional "homework buddy".
- MAY ONLY BE TURNED ON **GRADESCOPE** as a **PDF file**.
- There is NO MAKEUP for missed assignments.
- We are strict about enforcing the LATE POLICY for all assignments (see syllabus).

*Don't use a calculator or online solvers when working these problems. You will not be able to use them in exams either, so it's good practice to know how to do these!*

### Values of Different Bases

The following questions ask you what value a given number has for a given number in a given base. Write your answers in exponent form ( $10^3$ ) or a number multiplied by the exponent form ( $11 \cdot 10^4$ ). *Keep in mind that we start from position 0.*

For example:

In decimal, how much is a 1 in position 3 worth

**$10^3$**

- |                                                         |                        |
|---------------------------------------------------------|------------------------|
| 1. In binary, how much is a 1 in position 4 worth?      | <u>8</u> (answer)      |
| 2. In octal, how much is a 1 in position 4 worth?       | <u>512</u> (answer)    |
| 3. In hexadecimal, how much is a 1 in position 4 worth? | <u>4096</u> (answer)   |
| 4. In hexadecimal, how much is a 2 in position 4 worth? | <u>8192</u> (answer)   |
| 5. In hexadecimal, how much is a B in position 4 worth? | <u>45056</u> (answer)  |
| 6. In hexadecimal, how much is a 9 in position 5 worth? | <u>589824</u> (answer) |

### Converting Positive Decimal to Binary

Convert the following numbers into 8-bit binary, showing all bits.

For example:

Convert decimal 0 into binary.

**00000000**

7. Convert decimal 15 into binary.

**00001111**

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8. Convert decimal 2 into binary.

00000010

9. Convert decimal 8 into binary.

00001000

10. Convert decimal 65 into binary.

01000001

**Converting Binary to Decimal**

Convert the following unsigned binary numbers into decimal.

For example:

Convert binary 0000 into decimal.

**0**

11. Convert binary 1000 into decimal.

8

12. Convert binary 1001 into decimal.

9

13. Convert binary 1111 into decimal.

15

14. Convert binary 1101 into decimal.

13

**Converting Decimal to Hexadecimal**

Convert the following decimal numbers into 2-digit hexadecimal numbers, showing both digits preceded with the standard '0x' to indicate that the number is in hexadecimal.

For example:

Convert decimal 0 into hexadecimal.

**0x00**

15. Convert decimal 16 into hexadecimal.

0x10

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16. Convert decimal 65 into hexadecimal.

0x41

17. Convert decimal 31 into hexadecimal.

0x1F

18. Convert decimal 166 into hexadecimal.

0xA6

**Converting Binary to Hexadecimal**

Convert the following binary numbers into 2-digit hexadecimal numbers, showing both digits preceded with the standard '0x' to indicate that the number is in hexadecimal.

For example:

Convert binary 0 into hexadecimal.

**0x00**

19. Convert binary 110 into hexadecimal.

0x06

20. Convert binary 11110000 into hexadecimal.

0xF0

21. Convert binary 10110011 into hexadecimal.

0xB3

**Bit Positions**

Remember that we number bit positions from right to left, starting with 0.

For example:

The rightmost bit of an 8-bit number is in what position?

**Position 0**

The leftmost bit of an 8-bit number is in what position?

**Position 7**22. The rightmost bit of a 16-bit number is in what position? Position 0 (answer)23. The leftmost bit of a 16-bit number is in what position? Position 15 (answer)24. What is the 4-bit binary number that contains a 0 in all positions *except* for position 2?

0100 = 4

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**Terminology**25. How many bits are in a byte? 8 (answer)26. How many bits are in a nibble? 4 (answer)**Binary Addition**

Find the results of the following binary addition operations of numbers. **You must express the answer in 8 bits.** You have to assume that these numbers could be either *signed* or *unsigned*!

*Hint:* for the function of addition, it does not matter which of these they are – the 8-bit answer will be the same. You must also identify whether the addition created a carry out bit (C = 0 or 1) AND an overflow bit (V = 0 or 1) – use the usual convention of 0 means “no” and 1 means “yes”. Place this information after the 8-bit answer, separated by a comma.

For example:

EX1: What is

00101001

+ 11101001

00010010, C = 1 and V = 0

(i.e. there's a carry-out, but no overflow)

EX2: What is

10001001

+ 10001001

00010010, C = 1 and V = 1

(i.e. there's a carry-out, and there's overflow since 2 neg. numbers add up to a pos. number)

27. What is

10010001

+ 01100110

11110111, C = 0 and V = 0 (answer)

28. What is

11011011

+ 01100011

01111110, C = 1 and V = 0 (answer)

29. What is

00111101

+ 10110001

11101110, C = 0 and V = 0 (answer)

30. What is

10111101

+ 10000001

00111110, C = 1 and V = 1 (answer)