NAME: _____

SANTA CLARA UNIVERSITY
Department of Computer Engineering

COEN 020 Final Exam Fall 2016

(Closed Book & Notes; Honor Code Applies)

NOTE: This final exam consists of two parts with a break in between. You will only be allowed to leave the room during the break. You may take your break as soon as you have completed Part 1. You will be given Part 2 of the exam when you return from your break.

Total Time Allowed: 3 hours

SCU's Academic Integrity Pledge

"I am committed to being a person of integrity. I pledge, as a member of the Santa Clara University community, to abide by and uphold the standards of academic integrity contained in the Student Conduct Code."

Signature:_____

	Points	Maximum
Part 1:		72
Part 2:		75
Total:		147

Overall: _____ %

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1. [5 pts] Convert 110_{10} to base 3.

$110 \div 3 \rightarrow Q = 36, R = 2$
$36 \div 3 \rightarrow Q = 12, R = 0$
$12 \div 3 \rightarrow Q = 4, R = 0$
$4 \div 3 \rightarrow Q = 1, R = 1$
$1 \div 3 \rightarrow Q = 0, R = 1$ Answer = $\mathbf{11002_3}$

2. [5 pts] Convert 205_7 to base 10.

$205_7 = 2\times7^2 + 0\times7^1 + 5\times7^0$
$= 2\times49 + 0\times7 + 5\times1$
$= 98 + 0 + 5$
$= \mathbf{103_{10}}$

3. [5 pts] Convert 372.634_8 to base 16.

$372.634_8 = 011\ 111\ 010\ .\ 110\ 011\ 100_2$
$= 0\ 1111\ 1010\ .\ 1100\ 1110\ 0$
$= 1111\ 1010\ .\ 1100\ 1110$
$= \mathbf{F\ A\ .\ C\ E_{16}}$

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4. [5 pts] The closest representation of one-tenth as a Q8.8 fixed-point real is 00000000.00011010_2. Suppose you multiply this by ten. What is the decimal value of the result?

$00000000.00011010_2 = 26/2^8$

$10 \times 26/2^8 = 260/256 = \mathbf{1.015625_{10}}$

5. What is the <u>decimal</u> value of the following variables?

[2 pts] `int8_t x1 = (int8_t) 0xFF ;` **-1_{10}**

[2 pts] `int8_t x2 = (int8_t) 0x80 ;` **-128_{10}**

[2 pts] `uint8_t x3 = (uint8_t) 0xFF ;` **255_{10}**

[2 pts] `uint8_t x4 = (uint8_t) 0x80 ;` **128_{10}**

6. [5 pts] Assume you have two four-digit decimal integers 1040_{10} and 3020_{10} and a calculator that can only multiply two decimal digits times two decimal digits, producing a four digit product. Show how you would use this calculator to compute the product of X and Y by decomposing the operands into four two-digit numbers.

$1040_{10} = 10\times10^2 + 40, \quad 3020_{10} = 30\times10^2 + 20$

$1040_{10} \times 3020_{10} = (10\times10^2 + 40) \times(30\times10^2 + 20)$
$= 10\times30\times10^4 + (10\times20 + 40\times30)\times10^2 + 40\times20$
$= 300\times10^4 + (200 + 1200)\times10^2 + 800$

$= 3000000$
$+ \ 140000$
$+ \ \ \ 800$
$\mathbf{3140800_{10}}$

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7. Perform the following signed number base conversions:

a. [5 pts] Convert -61_{10} to 8-bit 2's complement

61_{10} = $32 + 16 + 8 + 4 + 1$
= $2^5 + 2^4 + 2^3 + 2^2 + 2^0$
= 00111101_2

-61_{10} = **11000011_2**

b. [5 pts] Convert -1.5_{10} to a 4.4 fixed-point real.

1.5_{10} = 0001.1000_2

-1.5_{10} = **1110.1000_2**

c. [5 pts] Convert the 4.4 fixed-point real 1100.0100_2 to base 10

1100.0100_2 = $-8 + 4 + .25$

= **-3.75_{10}**

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8. Suppose you use reciprocal multiplication to divide by 3 on a 4-bit computer.

   a. [4 pts] What is the corresponding integer constant multiplier?

   $2^4/3 = 16/3 = 5\frac{1}{3}$ → **5**

   b. [4 pts] What integer quotient would you get when the dividend is 9?

   $5 \times 9 = 45_{10} = 0010\ 1101_2$ → Integer Quotient = **2** (0010_2)

9. [10 pts total] Fill-in all the carry, borrow, sum and difference bits in the following operations and indicate if overflow occurs:

1	**1**	**1**	**0**	0	
	1	0	1	0	
+	1	1	1	0	
	1	**0**	**0**	**0**	

Unsigned overflow? **Yes**

2's complement overflow? **No**

1	**1**	**0**	**0**	0	
	1	0	1	0	
–	1	1	1	0	
	1	**1**	**0**	**0**	

Unsigned overflow? **Yes**

2's complement overflow? **No**

10. Suppose you need to divide a variable of type int32_t by 8 but your computer doesn't have a divide instruction. If you use an arithmetic shift right,

    a. [2 pts] What is the appropriate shift amount (i.e., how many bit positions do you shift)?

       3 bits

    b. [4 pts] What must you do to the variable before shifting to insure that the result will be correct, even if the variable contains a negative number?

       Add 7 to the dividend before applying the arithmetic right shift