21W-COMSCIM51A-1 Homework 1

CHARLES ZHANG

TOTAL POINTS

78 / 80

QUESTION 1

1 Question 1 2 / 2

✓ **- 0 pts Correct**

- 0.5 pts Minor error

- 1 pts Switched analog with digital

- 2 pts Blank

QUESTION 2

2 Question 2 2 / 2

✓ **- 0 pts Correct; **Combinational** and **Sequential****

- 1 pts Missing combinational

- 1 pts Missing sequential

QUESTION 3

3 Question 3 6 / 6

✓ **- 0 pts Correct**

- 1 pts A. Incorrect

- 1 pts B. Incorrect

- 1 pts C. Incorrect

- 2 pts A. Incorrect answer, no work

- 2 pts B. Incorrect answer, no work

- 2 pts C. Incorrect answer, no work

QUESTION 4

4 Question 4 4 / 4

✓ **- 0 pts Correct; (a) $$(0001111101)$$ (b) $$(1110000011)$$**

(a)

- 2 pts (a) wrong binary

- 1 pts (a) not in 10 bits

(b)

- 2 pts (b) wrong 2's complement

- 1 pts (b) not in 10 bits

QUESTION 5

5 Question 5 8 / 8

✓ **- 0 pts Correct**

- 1 pts A. Incorrect

- 1 pts B. Incorrect

- 1 pts C. Incorrect

- 1 pts D. Incorrect 3 digit max base 3

- 0.5 pts D. Incorrect base 10

- 2 pts A. Incorrect, no work

- 2 pts B. Incorrect, no work

- 2 pts C. Incorrect, no work

- 2 pts D. Incorrect, no work

QUESTION 6

6 Question 6 8 / 8

✓ **- 0 pts Correct; (a) $$(0101101)$$ (b) $$(00101101)$$ (c) $$(100101)$$ (d) $$(11100101)$$**

(a)

- 2 pts (a) wrong 2's complement

- 1 pts (a) MSB is not 0

(b)

- 2 pts (b) wrong answerr

- 1 pts (b) not in 8 bits

(c)

- 2 pts (c) wrong 2's complement

- 1 pts (c) MSB is not 0

(d)

- 2 pts (d) wrong answer

- 1 pts (d) not in 8 bits

QUESTION 7

7 Question 7 15 / 16

✓ **- 0 pts Correct**

- 1 pts A. Incorrect 2's complement

- **1 pts** A. Incorrect decimal

✓ - **1 pts** **A. Does not overflow**

- **1 pts** A. Sum should correct
- **1 pts** B. Incorrect 2's complement
- **1 pts** B. Incorrect decimal
- **1 pts** B. Does overflow
- **1 pts** B. Sum should be incorrect
- **1 pts** C. Incorrect 2's complement
- **1 pts** C. Incorrect decimal
- **1 pts** C. Does not overflow
- **1 pts** C. Sum should be correct
- **1 pts** D. Incorrect 2's complement
- **1 pts** D. Incorrect decimal
- **1 pts** D. Does overflow
- **1 pts** D. Sum should be incorrect

QUESTION 8

8 Question 8 16 / 16

✓ + **16 pts** **Correct![Screen_Shot_2021-01-15_at_9.18.58_PM.png](/files/1a31513a-bbd2-4872-bb57-2b475cbb4cbc)**

+ **0 pts** Placeholder; use point adjustment; 16*1 points

QUESTION 9

9 Question 9 8 / 8

✓ - **0 pts** **Correct**

- **1 pts** 1x incorrect decimal
- **1 pts** 1x incorrect binary
- **1.5 pts** Answers should be in 4 bit binary
- **4 pts** 4x incorrect binary

QUESTION 10

10 Question 10 9 / 10

- **0 pts** Correct ![Screen_Shot_2021-01-15_at_9.20.10_PM.png](/files/9e9167c2-b50c-4f05-ad15-0b733e3aa8fa)

Input set

- **0 pts** Correct (with three constraints)

✓ - **1 pts** **Missing the length of vector constraint (n >= 2)**

- **1 pts** Missing there is exactly two "1"s constraint
- **1 pts** Missing the item can be either 0 or 1 constraint

Output set

✓ - **0 pts** **Correct (positive number or [1, n-1])**

- **2 pts** Non-negative number
- **3 pts** Other answers

Input-output Function

✓ - **0 pts** **Any valid representations, inc. truth table, arithmetic expression, conditional expression, logical expression, composition of simpler function, function with textual description, python/c++/other PL implementations, etc.**

- **2 pts** Answer falls into the allowable representation but with slight issues (ex. ambiguity)
- **4 pts** Wrong answer

QUESTION 11

11 Academic Honesty Acknowledgement 0 / 0

✓ - **0 pts** **Correct**

- **0 pts** No AHA

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CS M51A, Winter 2021, Assignment 1
(Total Mark: 80 points, 8%)

Due: Wed Jan 13, 10:00 AM PT

Student Name: Charles Zhang
Student ID: 305-413-659

Note: You must complete the assignments entirely on your own, without discussing with others.

1. (2 points) Briefly outline the primary differences between digital and analog systems.
   Digital systems have discrete inputs and outputs, like a calculator.
   Analog systems have continuous inputs and outputs, like sound.

2. (2 points) What are the two types of digital systems?
   The 2 types of digital systems are combinational and sequential.

3. (6 points) Given the 8-bit binary number 1101 1010, give its decimal equivalent if these eight bits are interpreted as

   (a) an 8-bit unsigned number. (show your steps)
   $1\ 1\ 0\ 1\ \ 1\ 0\ 1\ 0$
   $2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
   $2^7+2^6+2^4+2^3+2^1 = \boxed{218}$

   (b) an 8-bit signed magnitude number. (show your steps)
   $1\ 1\ 0\ 1\ \ 1\ 0\ 1\ 0$
   $\leftrightarrow 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
   $-(2^6+2^4+2^3+2^1) = \boxed{-90}$

   (c) an 8-bit 2's complement number.
   $1\ 1\ 0\ 1\ \ 1\ 0\ 1\ 0$
   $-2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
   $-2^7+2^6+2^4+2^3+2^1 = \boxed{-38}$

4. (4 points) Number Representation

   (a) Write the number 125 in binary, extended to 10 bits.
   $2^6+2^5+2^4+2^3+2^2+2^0 = 64+32+16+8+4+1 = 125$ ✓
   $\boxed{0001111101}$

   (b) Compute the 2s complement negation of the 10-bit number in (a).
   ↳ complement bits, add 1
   ↳ $1110000010 + 0000000001 =$ $\boxed{1110000011}$

5. (8 points)Find x and y such that the following conditions are satisfied and show all the steps of your work.

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1 Question 1 **2 / 2**

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4. (4 points) Number Representation

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   ↳ complement bits, add 1
   ↳ $1110000010 + 0000000001 =$ $\boxed{1110000011}$

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- 1 pts Missing sequential

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3 Question 3 6 / 6

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- 1 pts B. Incorrect

- 1 pts C. Incorrect

- 2 pts A. Incorrect answer, no work

- 2 pts B. Incorrect answer, no work

- 2 pts C. Incorrect answer, no work

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5. (8 points)Find x and y such that the following conditions are satisfied and show all the steps of your work.

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4 Question 4 4 / 4

✓ - **0 pts** **Correct; (a) $$(0001111101)$$ (b) $$(1110000011)$$**

(a)

- **2 pts** (a) wrong binary
- **1 pts** (a) not in 10 bits

(b)

- **2 pts** (b) wrong 2's complement
- **1 pts** (b) not in 10 bits

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5)

(a) $(817)_9 = (x)_3$ → Every digit in r=9 is 2 in r=3 → $(8)_9 = (22)_3$, $(1)_9 = (01)_3$, $(7)_9 = (21)_3$ → $(220121)_3$

(b) $(111)_4 = (x)_2$. → Every digit in r=4 is 2 in r=2 → $(1)_4 = (01)_2$, $(1)_4 = (01)_2$, $(1)_4 = (01)_2$ → $(10101)_2$

(c) $(100)_6 = (x)_9$. $1\,00_{6^2\ 6^1\ 6^0} = (76)_{10}$ → $(9^2)_{10} > (36)_{10} > (9^1)_{10}$ → $4 \times 9^1 = (36)_{10}$ → $(40)_9$

(d) What is the largest number y that can be represented with 3 digit in radix 3. Show y in radix 3 and decimal.. $y = 3^3 - 1 = 26$

$y = (222)_3 = (2\times3^2) + (2\times3^1) + (2\times3^0) =$
$18 + 6 + 2 = 26$ ✓

6. (8 points) Two's Complement

(a) Write 45 in two's complement representation. 0101101 → $2^5+2^3+2^2+2^0 = 45$ ✓

(b) Sign extend the number in part (a) to 8 bits. 00101101 → Add MSBs

(c) Write -27 in two's complement representation. 100101 → $-2^5+2^2+2^0 = -27$ ✓

(d) Sign extend the number in part (c) to 8 bits. 11100101 → Add MSBs

7. (16 points) Add the following pairs of 8-bit two's complement binary numbers, giving a 8-bit result (i.e., throw away the carry-out). Also give the signed decimal value of the the 8-bit result. Note whether or not an overflow occurred for any addition.

	1111 1111 (-1) +0000 0001 (1) → 0
2's Complement Binary:	0000 0000
Signed Decimal:	0
Overflow?	Yes
Is the sum correct?	Yes

	0110 1010 (106) +0010 1101 (45) → 151
2's Complement Binary:	1001 0111
Signed Decimal:	-105
Overflow?	Yes
Is the sum correct?	No

	0010 1100 (44) +0011 1101 (61) → 105
2's Complement Binary:	0110 1001
Signed Decimal:	105
Overflow?	No
Is the sum correct?	Yes

	1011 1001 (185) +1011 0001 (177) → 362
2's Complement Binary:	0110 1010
Signed Decimal:	106
Overflow?	Yes
Is the sum correct?	No

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5 Question 5 **8 / 8**

✓ **- 0 pts Correct**

- 1 pts A. Incorrect

- 1 pts B. Incorrect

- 1 pts C. Incorrect

- 1 pts D. Incorrect 3 digit max base 3

- 0.5 pts D. Incorrect base 10

- 2 pts A. Incorrect, no work

- 2 pts B. Incorrect, no work

- 2 pts C. Incorrect, no work

- 2 pts D. Incorrect, no work

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Overflow?	Yes
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Overflow?	No
Is the sum correct?	Yes

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2's Complement Binary:	0110 1010
Signed Decimal:	106
Overflow?	Yes
Is the sum correct?	No

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6 Question 6 **8 / 8**

✓ **- 0 pts Correct; (a) $$(0101101)$$ (b) $$(00101101)$$ (c) $$(100101)$$ (d) $$(11100101)$$**

(a)

- **2 pts** (a) wrong 2's complement
- **1 pts** (a) MSB is not 0

(b)

- **2 pts** (b) wrong answerr
- **1 pts** (b) not in 8 bits

(c)

- **2 pts** (c) wrong 2's complement
- **1 pts** (c) MSB is not 0

(d)

- **2 pts** (d) wrong answer
- **1 pts** (d) not in 8 bits

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Signed Decimal:	106
Overflow?	Yes
Is the sum correct?	No

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7 Question 7 15 / 16

✓ - 0 pts **Correct**

- 1 pts A. Incorrect 2's complement
- 1 pts A. Incorrect decimal

✓ - 1 pts **A. Does not overflow**

- 1 pts A. Sum should correct
- 1 pts B. Incorrect 2's complement
- 1 pts B. Incorrect decimal
- 1 pts B. Does overflow
- 1 pts B. Sum should be incorrect
- 1 pts C. Incorrect 2's complement
- 1 pts C. Incorrect decimal
- 1 pts C. Does not overflow
- 1 pts C. Sum should be correct
- 1 pts D. Incorrect 2's complement
- 1 pts D. Incorrect decimal
- 1 pts D. Does overflow
- 1 pts D. Sum should be incorrect

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8. (16 points) Draw and fill a truth table for a system which has three inputs (a, b, c) and two outputs (f, g). f and g functions are defined as follow.

- f is a majority function (i.e. it is 1 when more than half of the inputs are 1)
- g is a minority function(i.e. it is 1 when less than half of the inputs are 1.)

(a,b,c)	f(a,b,c)	g(a,b,c)
0 0 0	0	1
0 0 1	0	1
0 1 0	0	1
0 1 1	1	0
1 0 0	0	1
1 0 1	1	0
1 1 0	1	0
1 1 1	1	0

9. (8 points) For the following high-level specification, determine the output in both decimal and 4-bits binary. ->unsigned

- Input $x \in \{0, 1, 2, 3\}$
- Function $y(x) = x^2 + 2$

$y(0) = 0+2 = 2 = (10)_2$
$y(1) = 1+2 = 3 = (11)_2$
$y(2) = 4+2 = 6 = (110)_2$
$y(3) = 9+2 = 11 = (1011)_2$

$y \in (\{2, 3, 6, 11\})_{10}$

$y \in (\{0010, 0011, 0110, 1011\})_2$

10. (10 points) Find out a high-level specification (input set, output set and input-output function) for a combinational system that compute the distance between two 1's in the input bit-vector $x = (x_{n-1}, \cdots x_0)$. Assume x has exactly two 1's. For example, if $x = (1, 0, 0, 1)$, then the distance is 3.

input: $x = \{(x_{n-1}, \ldots, x_0) \mid n>0, x_i = 0 \text{ or } 1, \sum_{i=0}^{n-1} x_i = 2\}$

output: $y = \mathbb{N}^+$, $y \leq n-1$ $f: f(x) = i-j$ if $x_i = 1$ and $x_j = 1$ and $i>j$

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8 Question 8 16 / 16

✓ **+ 16 pts** **Correct![Screen_Shot_2021-01-15_at_9.18.58_PM.png](/files/1a31513a-bbd2-4872-bb57-2b475cbb4cbc)**

+ 0 pts Placeholder; use point adjustment; 16*1 points

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(a,b,c)	f(a,b,c)	g(a,b,c)
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$y(0) = 0+2 = 2 = (10)_2$
$y(1) = 1+2 = 3 = (11)_2$
$y(2) = 4+2 = 6 = (110)_2$
$y(3) = 9+2 = 11 = (1011)_2$

$y \in (\{2, 3, 6, 11\})_{10}$

$y \in (\{0010, 0011, 0110, 1011\})_2$

10. (10 points) Find out a high-level specification (input set, output set and input-output function) for a combinational system that compute the distance between two 1's in the input bit-vector $x = (x_{n-1}, \cdots x_0)$. Assume x has exactly two 1's. For example, if $x = (1, 0, 0, 1)$, then the distance is 3.

input: $x = \{(x_{n-1}, \ldots, x_0) \mid n>0, x_i = 0 \text{ or } 1, \sum_{i=0}^{n-1} x_i = 2\}$

output: $y = \mathbb{N}^+$, $y \leq n-1$ $f: f(x) = i-j$ if $x_i = 1$ and $x_j = 1$ and $i>j$

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9 Question 9 **8 / 8**

✓ **- 0 pts Correct**

- 1 pts 1x incorrect decimal

- 1 pts 1x incorrect binary

- 1.5 pts Answers should be in 4 bit binary

- 4 pts 4x incorrect binary

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8. (16 points) Draw and fill a truth table for a system which has three inputs (a, b, c) and two outputs (f, g). f and g functions are defined as follow.

- f is a majority function (i.e. it is 1 when more than half of the inputs are 1)
- g is a minority function(i.e. it is 1 when less than half of the inputs are 1.)

(a,b,c)	f(a,b,c)	g(a,b,c)
0 0 0	0	1
0 0 1	0	1
0 1 0	0	1
0 1 1	1	0
1 0 0	0	1
1 0 1	1	0
1 1 0	1	0
1 1 1	1	0

9. (8 points) For the following high-level specification, determine the output in both decimal and 4-bits binary. ->unsigned

- Input $x \in \{0, 1, 2, 3\}$
- Function $y(x) = x^2 + 2$

$y(0) = 0+2 = 2 = (10)_2$
$y(1) = 1+2 = 3 = (11)_2$
$y(2) = 4+2 = 6 = (110)_2$
$y(3) = 9+2 = 11 = (1011)_2$

$y \in (\{2, 3, 6, 11\})_{10}$

$y \in (\{0010, 0011, 0110, 1011\})_2$

10. (10 points) Find out a high-level specification (input set, output set and input-output function) for a combinational system that compute the distance between two 1's in the input bit-vector $x = (x_{n-1}, \cdots x_0)$. Assume x has exactly two 1's. For example, if $x = (1, 0, 0, 1)$, then the distance is 3.

input: $x = \{(x_{n-1}, \ldots, x_0) \mid n>0, x_i = 0 \text{ or } 1, \sum_{i=0}^{n-1} x_i = 2\}$

output: $y = \mathbb{N}^+$, $y \leq n-1$ $f: f(x) = i-j$ if $x_i = 1$ and $x_j = 1$ and $i>j$

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10 Question 10 9 / 10

- **0 pts** Correct ![Screen_Shot_2021-01-15_at_9.20.10_PM.png](/files/9e9167c2-b50c-4f05-ad15-0b733e3aa8fa)

Input set

- **0 pts** Correct (with three constraints)

✓ - **1 pts** **Missing the length of vector constraint (n >= 2)**

- **1 pts** Missing there is exactly two "1"s constraint
- **1 pts** Missing the item can be either 0 or 1 constraint

Output set

✓ - **0 pts** **Correct (positive number or [1, n-1])**

- **2 pts** Non-negative number
- **3 pts** Other answers

Input-output Function

✓ - **0 pts** **Any valid representations, inc. truth table, arithmetic expression, conditional expression, logical expression, composition of simpler function, function with textual description, python/c++/other PL implementations, etc.**

- **2 pts** Answer falls into the allowable representation but with slight issues (ex. ambiguity)
- **4 pts** Wrong answer

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CS M51A, Winter 2021, Assignment 1
(Total Mark: 80 points, 8%)

Due: Wed Jan 13, 10:00 AM PT

Student Name: Charles Zhang
Student ID: 305-413-659

Note: You must complete the assignments entirely on your own, without discussing with others.

1. (2 points) Briefly outline the primary differences between digital and analog systems.
   Digital systems have discrete inputs and outputs, like a calculator.
   Analog systems have continuous inputs and outputs, like sound.

2. (2 points) What are the two types of digital systems?
   The 2 types of digital systems are combinational and sequential.

3. (6 points) Given the 8-bit binary number 1101 1010, give its decimal equivalent if these eight bits are interpreted as

   (a) an 8-bit unsigned number. (show your steps)
   $1\ 1\ 0\ 1\ \ 1\ 0\ 1\ 0$
   $2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
   $2^7+2^6+2^4+2^3+2^1 = \boxed{218}$

   (b) an 8-bit signed magnitude number. (show your steps)
   $1\ 1\ 0\ 1\ \ 1\ 0\ 1\ 0$
   $\leftrightarrow 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
   $-(2^6+2^4+2^3+2^1) = \boxed{-90}$

   (c) an 8-bit 2's complement number.
   $1\ 1\ 0\ 1\ \ 1\ 0\ 1\ 0$
   $-2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
   $-2^7+2^6+2^4+2^3+2^1 = \boxed{-38}$

4. (4 points) Number Representation

   (a) Write the number 125 in binary, extended to 10 bits.
   $2^6+2^5+2^4+2^3+2^2+2^0 = 64+32+16+8+4+1 = 125$ ✓
   $\boxed{0001111101}$

   (b) Compute the 2s complement negation of the 10-bit number in (a).
   ↳ complement bits, add 1
   ↳ $1110000010 + 0000000001 =$ $\boxed{1110000011}$

5. (8 points)Find x and y such that the following conditions are satisfied and show all the steps of your work.

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11 Academic Honesty Acknowledgement 0 / 0

✓ **- 0 pts** **Correct**

- 0 pts No AHA

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