

CS M51A, Winter 2021, Assignment 1

(Total Mark: 80 points, 8%)

Due: Wed Jan 13, 10:00 AM PT

Student Name:

Student ID:

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 use discrete values while analog systems use continuous values.

2. (2 points) What are the two types of digital systems?

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) **218**

(b) an 8-bit signed magnitude number. (show your steps) **-90**

(c) an 8-bit 2's complement number. **-38**

4. (4 points) Number Representation

(a) Write the number 125 in binary, extended to 10 bits. **0001111101**

(b) Compute the 2s complement negation of the 10-bit number in (a). **1110000011**

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

(a) $(817)_9 = (x)_3$ **220121**

(b) $(111)_4 = (x)_2$. **10101**

(c) $(100)_6 = (x)_9$. **40**

(d) What is the largest number y that can be represented with 3 digit in radix 3. Show y in radix 3 and decimal..

222 and 26

6. (8 points) Two's Complement

(a) Write 45 in two's complement representation. **0101101**

(b) Sign extend the number in part (a) to 8 bits. **00101101**

(c) Write -27 in two's complement representation. **100101**

(d) Sign extend the number in part (c) to 8 bits. **11100101**

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
	+0000 0001
2's Complement Binary:	0000 0000
Signed Decimal:	0
Overflow?	No
Is the sum correct?	Yes

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

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

	1011 1001
	+1011 0001
2's Complement Binary:	0110 1010
Signed Decimal:	106
Overflow?	Yes
Is the sum correct?	No

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	g
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.

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

Output $y \in \{2, 3, 6, 11\}$

Output $y \in \{0010, 0011, 0110, 1011\}$

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 $x = (x_{n-1}, \dots, x_0)$. Assume x has exactly two 1's. For example, if $x = (1, 0, 0, 1)$, then the distance is 3.

Input: $x \in \{(x_{n-1}, \dots, x_0) \mid n \geq 1, \text{sum}(x_{n-1}, \dots, x_0) = 2, x_i \in \{0, 1\} \text{ for } (0 \leq i \leq n-1)\}$

Function: $y(x) = j - i$ if $x_j = 1$ and $x_i = 1$ and $j > i$

Output: $y \in \{1, 2, 3, \dots, n-1\}$ or \mathbb{N}^+ (any positive number)