CS 220 Computer Architecture

HW 02 - Number Systems and Computer Arithmetic I

Fall 2023

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION SYSTEMS

PART 0: READING

- **Chapter 10** - Number Systems
- **Chapter 11** - Computer Arithmetic | **11.1 - 11.3**

PART 1: QUESTIONS ON NUMBER SYSTEM [54 PTS]

QUESTION 1

Describe each of the following key terms. [14 pts]

1. Base	The part of the number system that holds a value place. (ex: 10 in base 5 would be 20 because 5 can only hold)
2. Binary	A base of two; typically used in code. (ex: 3 would be 11; 1 for the first and 1 for the second base)
3. Least significant digit	The base of the rightmost point, as it holds the lowest digit.
4. Most significant digit	The base of the leftmost point, as it holds the highest digit.
5. Positional number system	A system of which numbers either go left for bigger values or right for smaller values. The numbers move away from the radix and their position is determined by the i value. (ex: r^i)
6. Radix point	The point at which all numbers branch off of. Left for bigger values, right for smaller.

7. Decimal, binary, hexadecimal	Decimal - Numbers that are smaller than a whole number, typically represented with a dot and a number to the right. Binary - A base of two; typically used in code. Hexadecimal - A base 16 number system that uses 0 through 9 and the letters A through F to represent its values.

QUESTION 2

Order the numbers $1.1_{(2)}$, $1.4_{(10)}$, and $1.5_{(16)}$ from smallest to largest. [5 pts]

Smallest	Middle	Largest
1.5(16)	1.4	1.1(2)

QUESTION 3

Convert the following binary numbers to their equivalents. [8 pts]

Binary	Hexadecimal	Decimal
1001.1111	9.F	9.9375
110101.011001	35.64	53.390625
10100111.111011	A7.EC	167.921875
1111 1111 0101 1010	FF5A	65370

QUESTION 4

Convert the following hexadecimal numbers to their equivalents. [12 pts]

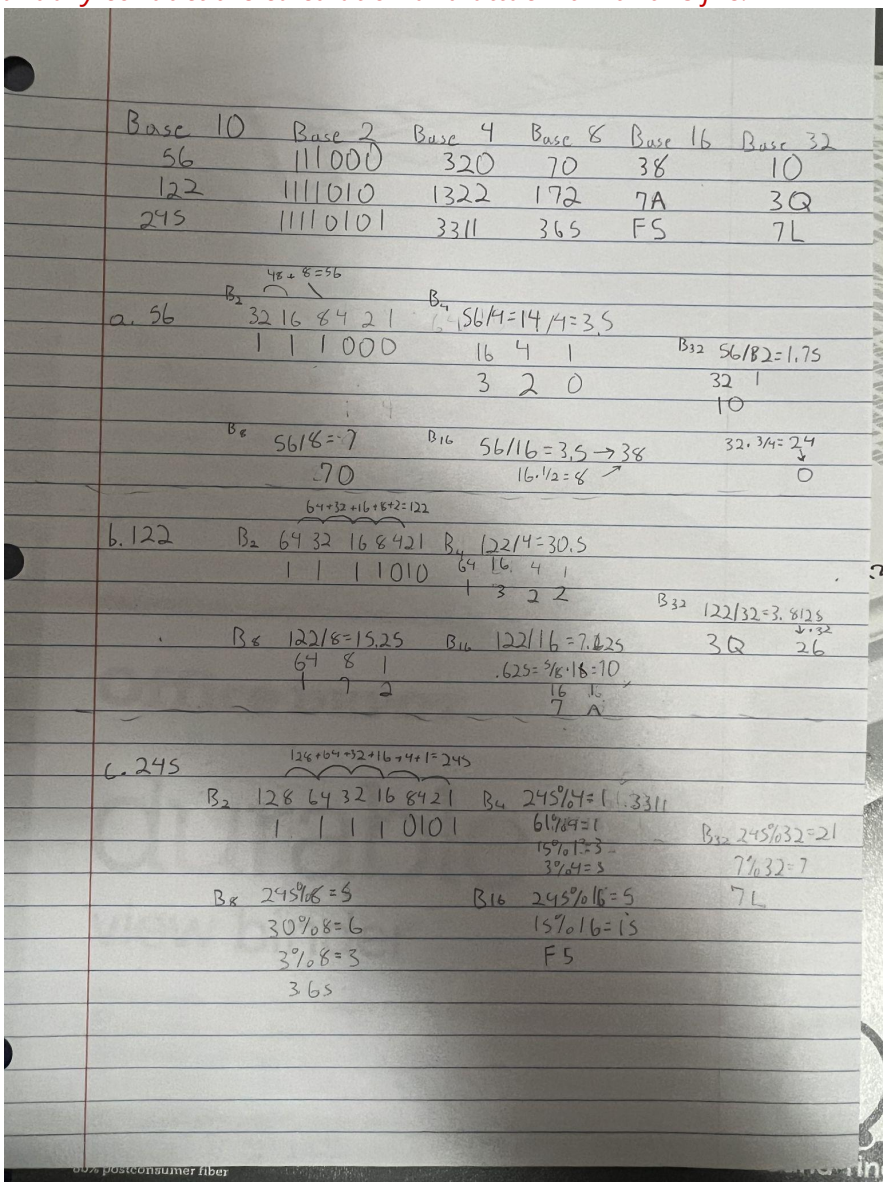
Hexadecimal	Binary	Decimal
E	1110	14
A64	101001100100	2660
1F.C	11111.110	31.75
239.4	001000111001.010	569.25

ABCD	1010101111001101	43981
67E	11001111110	1662

QUESTION 5

Perform the indicated base conversions. [15 pts]

- *Note: Manually conduct the calculation and attach it with this file.*



Base 10	Base 2	Base 4	Base 8	Base 16	Base 32

56	111000	320	70	38	1O
122	1111010	1322	172	7A	3Q
245	11110101	3311	365	F5	7L

PART 2: QUESTIONS ON COMPUTER ARITHMETIC 1 [46 PTS]

QUESTION 1

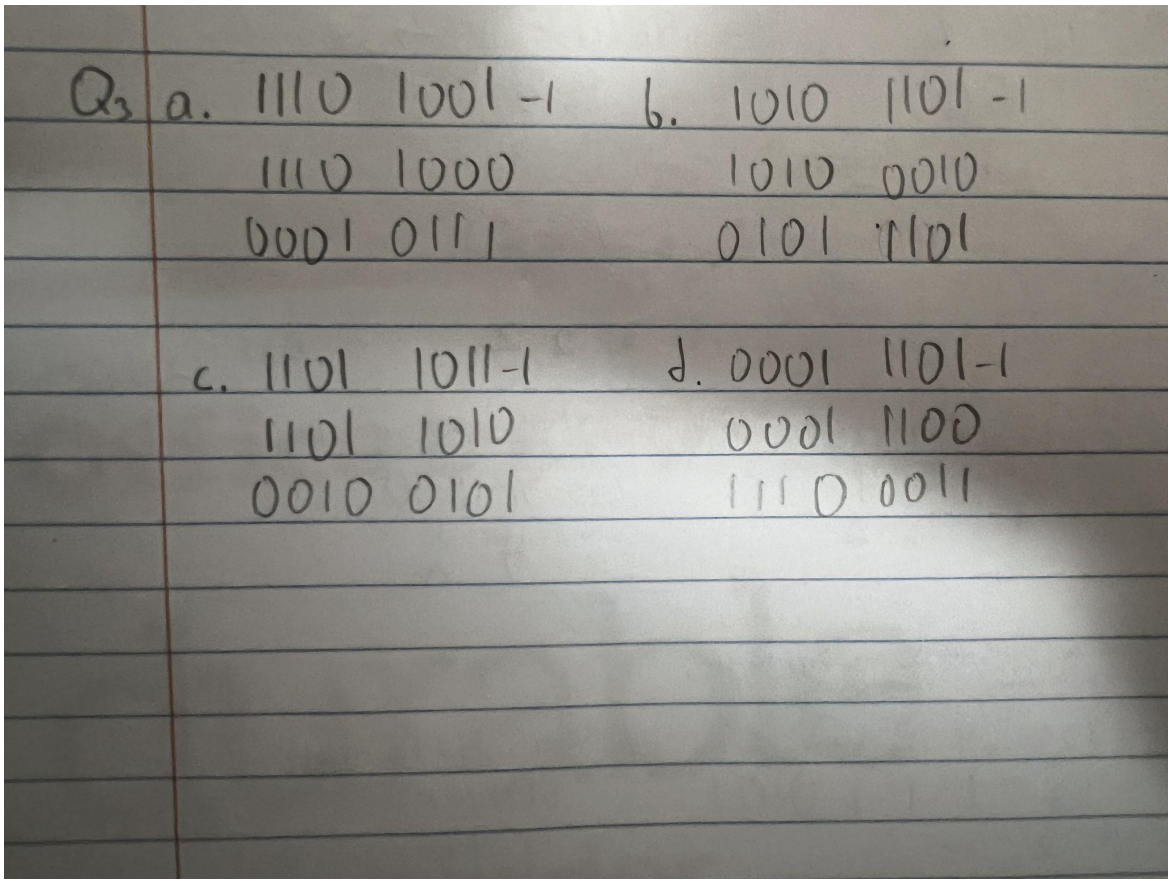
Briefly explain the following representations. [10 pts]

Sign magnitude	The use of using the leftmost bit as a way to hold a sign rather than a number. This allows for negative ranges instead of a large positive range.
Two's complement	The process of inverting a binary number's ones and zeros to get their negative
Biased	The range of a binary. Typically found by (2^k -1) where k is the number of bits.
Fixed - point	A number that consists of a definite integral part and a fractal part
Floating point	A number that does not reserve an integral part, and is more lenient of giving space to the fractional part

QUESTION 2

Represent the following decimal numbers in both binary sign magnitude and **16-bit** twos complement. [8 pts]

- *Note: Manually conduct the calculation and attach it with this file.*



Decimal	sign magnitude	16-bit two's complement
+512	0000 0010 0000 0000	1111 1110 0000 0000
-29	1111 1111 1110 0011	0000 0000 0001 1101
+1022	0000 0011 1111 1110	1111 1100 0000 0010
-1022	1111 1100 0000 0010	0000 0011 1111 1110

QUESTION 3

Represent the following **8-bit two's complement** in decimal and sign magnitude. [8 pts]

- *Note: Manually conduct the calculation and attach it with this file.*

Decimal	sign magnitude	two's complement
23	0001 0111	**1110 1001**
83	0101 1101	**1010 1101**
37	0010 0101	**1101 1011**
-29	1110 0011	**0001 1101**

QUESTION 4

Given decimal numbers A and B. Show their 8-bit representations and the calculation of negation, addition, and subtraction. [20 pts]

- *Note: Manually conduct the calculation and attach it with this file.*

Negation: Show their 8-bit two's complement for A, B, -A, and -B

Decimal	8-bit two's complement			
A = 6 &	**A**	**0000 0110**	**B**	**0000 1101**

B = 13	**-A**	**1111 1010**	**-B**	**1111 0011**

Addition and Subtraction

A	**B**	**A + B**	**A - B**
6	13	0001 0011	1111 1001
-6	13	0000 0111	1110 1101
-6	-13	1110 1101	0000 0111