

Exam # 1 - CSc 137, Fall 2020

(Please show all work)

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1. What is the 16-bit FP number representation of -7.375 in hex with 1-bit sign, 4-bit biased exponent, and 11-bit fraction, where bias = 7. Please identify the key components of FP number representation (25 pts)

Step 1 | Convert Decimal to Binary -7.375

Convert Integer: 7

$$\begin{array}{r} 3 \\ 2 \overline{)7} \rightarrow 2 \overline{)3} \rightarrow 2 \overline{)1} \\ \underline{-6} \quad \underline{-2} \quad \underline{-0} \\ 1 \quad 1 \quad 1 \end{array}$$

$$7_{(10)} = 111_{(2)}$$

Convert Fractional: 0.375

* Successive multiplication of remaining products *

$$\begin{aligned} 0.375 &\times 2 = 0 + 0.75 \\ 0.75 &\times 2 = 1 + 0.5 \\ 0.5 &\times 2 = 1 + 0.0 \leftarrow \text{Reached zero} \\ 0.375_{(10)} &= 011_{(2)} \end{aligned}$$

Together

$$-7.375 = 111.011$$

Step 3 | Add Biased Exponent: 1.11011

Biased Offset = 7 * This will be provided in assignments and exams *

$$\text{Biased Exponent} = 1.11011 \times 2^4$$

$$4 + 7 = \boxed{11}_{(10)} \rightarrow 11 = 1011_{(2)}$$

Convert to Binary

Step 5 | Convert to Hex - Final Step

Number	0	1	2	3	4	5	6	7
Binary	0000	0001	0010	0011	0100	0101	0110	0111
Hexadecimal	0	1	2	3	4	5	6	7

Number	8	9	10	11	12	13	14	15
Binary	1000	1001	1010	1011	1100	1101	1110	1111
Hexadecimal	8	9	A	B	C	D	E	F

1101111011000000

0xD 0xE 0xC 0x0

Converted Hex Value: 0xDEC0

Step 2 | Converting Binary to Scientific Notation

$$-7.375 = 111.011_{(2)}$$

Convert 111.011₍₂₎ to Scientific Notation

$$\underset{2}{\cancel{1}}.011_{(2)} \xrightarrow{\text{Scientific Notation}} 1.11011_{(2)} \times 2^2$$

Step 4 | Fusion of Floating Point

Biased Component

$$\underline{1.11011} \times 2^{\boxed{9}} = 1011_{(2)}$$

Signed Component Fractional Component

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	1	0	1	1	1	0	1	1	0	0	0	0	0	0	0

Signed Bit

* When Signed component is positive set to 0(zero)

* When Signed component is negative set to 1

Mantissa / Fraction

2. Please circle the best answer about Von Neumann architecture below (25 pts)

- A. Only data is stored in primary memory
- B. Only instructions are stored in primary memory
- C. Data and instructions are both stored in primary memory
- D. None of Above

Primary = Ram
Secondary = Hard/SSD

The bottleneck in Von Neumann architecture is that the processor is idle for a certain amount of time while memory is accessed.

3. Using Boolean Algebra, simplify the following logical expression? (25 pts)

$$F = AB + A(B+C) + B(B+C)$$

$$F = AB + A(B+C) + B(B+C)$$

$$\rightarrow AB + A(B+C) + \underbrace{B}_{: \text{Absorption}}$$

$$AB + A(B+C) + B$$

$$\rightarrow AB + \underbrace{AB+AC}_{: \text{Distributive}} + B$$

$$AB + AB + AC + B$$

$$\rightarrow \underbrace{AB}_{: \text{Idempotent?}} + AC + B$$

$$AB + AC + B$$

$$\rightarrow \underbrace{A(B+C)}_{: \text{Distributive}} + B$$

$$A(B+C) + B$$

$$\rightarrow A \underbrace{B+C}_{(A*B+C) \leftarrow \text{Solution}}$$

$$(A*B+C) \leftarrow \text{Solution}$$

Standard Precedence Levels		
0	\neg	Negation
1	\wedge	Intersection
2	\vee	Union
3	\oplus	XOR
	\rightarrow	Implication

4. Design a Single cell 1 bit Carry propagate (or Ripple Carry Adder) full adder. (25 pts)

a. Generate the truth table

b. Using K-map or Boolean algebra, determine the logical expression for Carry out (C-out) and Sum (S) Outputs

C. Draw the circuit diagram of the outputs in step b

Q. $X = \Phi 111$
 $Y = 1111$

Inputs			Outputs	
X	Y	Z-in	S	Z-out
1	1	0	0	1
1	1	1	1	1
1	1	1	1	1
0	1	1	0	1

Always Zero

S = SUM

b. Output Logical Expression

$$S = \bar{x}\bar{y}z_{\text{-in}} + \bar{x}y\bar{z}_{\text{-in}} + x\bar{y}\bar{z}_{\text{-in}} + xy{z}_{\text{-in}}$$

$$Z_{\text{-out}} = \bar{x}yz_{\text{-in}} + x\bar{y}z_{\text{-in}} + xy\bar{z}_{\text{-in}} + xyz_{\text{-in}}$$

K-map of the Output Logical Expression

$$S = \bar{x}\bar{y}z_{\text{-in}} + \bar{x}y\bar{z}_{\text{-in}} + x\bar{y}\bar{z}_{\text{-in}} + xy{z}_{\text{-in}}$$

	00	01	11	10
0	1			1
1	1		1	

* See what changes in the implicants * * $\oplus = \text{XOR}$ *

$$S_{\text{-simplified}} = X \oplus Y \oplus Z_{\text{-in}}$$

Z-out = $\bar{x}yz_{\text{-in}} + x\bar{y}z_{\text{-in}} + xy\bar{z}_{\text{-in}} + xyz_{\text{-in}}$				
	00	01	11	10
0	0	0	1	0
1	1	1	1	1

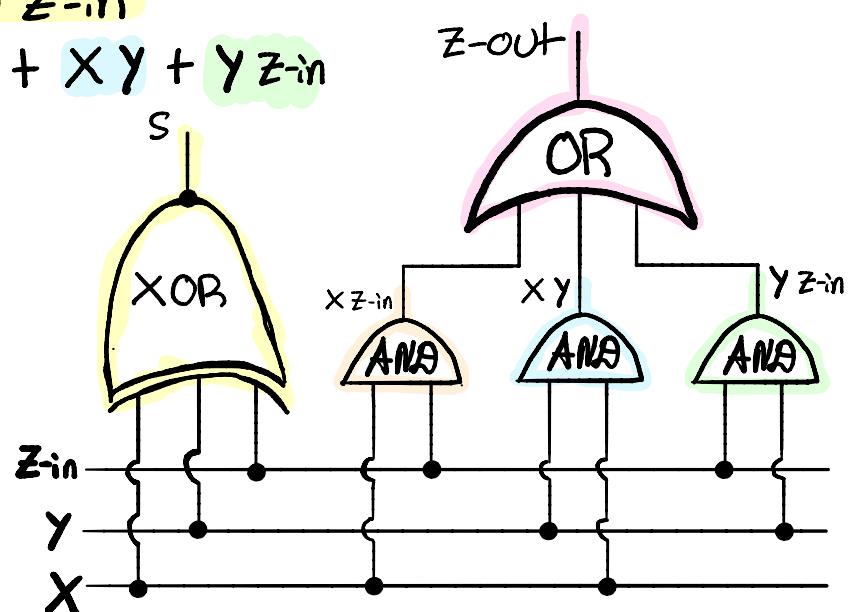
Important 02
BZ-in
Important 01
XB

Important 00
XZ-in

* See what changes in the implicants *
Z-out simplified = $XZ_{\text{-in}} + XY + YZ_{\text{-in}}$

C. S-simplified = $X \oplus Y \oplus Z_{\text{-in}}$

$$Z_{\text{-out}} \text{ simplified} = XZ_{\text{-in}} + XY + YZ_{\text{-in}}$$



Conversion Table:

Decimal (Base 10)	Binary (Base 2)	Hexadecimal (Base 16)
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F