

COEN 311 Section W (Computer Organization and Software)

Assignment 1

Due Monday January 31, 2022

Note: Please submit only one PDF file through Moodle.

Question 1 (Data Representation) *15 points*

(a) Convert the following pairs of decimal numbers to 5-bit, signed, 2's complement numbers and add them. State, whether or not overflow occurs in each case.

1) 5 and 10

No Overflow

2) 7 and 13

Carry 1

(7) 00111

(13) + 01101

(20) 0 10100

Carry in = 1, Carry out = 0. There is an Overflow.

3) -14 and 11

No Overflow

4) -10 and -13

Carry 0

(-10) 10110

(-13) + 10011

(-23) 1 11001

Carry in = 0, Carry out = 1. There is an Overflow.

(b) Repeat Part (a) for the subtract operation, where the second number of each pair is to be subtracted from the first number. State whether or not overflow occurs in each case.

1) 5 - 10

2) 7 - 13

3) -14 - 11

4) -10 - (-13)

There will be Overflow only in 3)

Question 2 (Data Representation) 15 points

Give an interpretation to the following string of bits assuming it is:

1100 0110 1001 0111

- Unsigned Integer
 $\$C697 = (50839)_{10}$
- Signed Integer
 $-\$3969 = -(14697)_{10}$
- BCD number
NA 6 9 7
- String of ASCII characters
C697 = NA a
- IEEE 754 Floating Point number
 $S = -1$
 $E' = 1000\ 1101 = \$8D = 141$
 $M = 001\ 0111$
 $(-1)^S \times 2^{(E'-127)} \times 1.M = (-1)^1 \times 2^{(141-127)} \times 1.0010111$
 $= -2^{14} \times (1.0010111)_2$
 $= -16,384 \times (1.1796875)_{10}$
 $= -19,328$

Question 3 (Memory) 10 points

Consider a computer that has a *byte organized* memory. A program reads numbers entered at a keyboard and stores them as *words* in successive byte locations, starting at location 1000. Show the contents of memory locations when decimals (-14) and (11) are entered, and their addition is stored in the successive location(s).

-14 as a word = FFF2 at memory location \$1000

11 as a word = 000B at memory location \$1002

-3 as a word = FFFD at memory location \$1004

Question 4 (Memory) 10 points

Consider a microprocessor system where the processor has 16-bit data bus and 22-bit address bus. What is the maximum size of the byte addressable memory that can be connected with this processor?

Address bus is used to address memory locations, so we must consider address bus to calculate the maximum memory size. With 22 bits address bus $\rightarrow 2^{22}$ memory locations (cells) can be addressed. Also, the memory is byte addressable, therefore,
Max Memory capacity = no. of memory locations that we can be addressed with 22 bits * size of each memory location = $2^{22} \times 1 \text{ byte} = 4 \times 1 \text{ M byte} = 4 \text{ MB}$.

Question 5 (Memory) 50 points

A byte organized memory chip with 12 bit address bus is used as a building block in a

larger memory organization.

a) Calculate the capacity of the above chip. (10 points)

$$\text{Capacity} = 2^{12} \text{ bytes} = 4 \text{ Kbytes}$$

b) If the above chip is used to build a 64 KByte word organized (16 bit) memory, how many address lines should the CPU have, and how many of these address lines are used for the decoder. (15 points)

You will need $(64 \text{ Kbyte}/4\text{Kbyte}) = 16$ memory chips

2 memory chips are used to make a word organized memory.

There will be 8 such rows of 2 memory chips in each row (since there are a total of 16 memory chips)

3 address lines are therefore required to select one of the $2^3 = 8$ memory chips.

The CPU therefore requires 15 address lines. 12 of these 15 address lines go to each memory chip. The rest 3 address lines are used for the decoder.

c) Draw the memory Connections to the CPU for this new Memory System. (25 points)

