## CSC 120 Lab 02

This lab is designed to test your understanding of the basics of bit manipulation and digital logic. There are 4 different sections each helping you to build skills in a particular area**. Details about how to approach this lab are provided in the Lab 02 overview lecture.** Please provide references of your work in the references area for Exploration challenge and Programming challenge. You can just add a list of urls or book chapter number and section. For example, if you referred to chapter 1 from the book just add that as a reference.. Make sure you attempt everything as there are points for attempting. **You are allowed to research online and reference material from online sources but do not copy,paste directly from other sources as this will be an honor code violation. You have unlimited time to answer the questions till the due date.** Good luck!

### Section A Design Challenge (15 points)

You want to develop a convention for digital communication that can send and receive messages only in the binary format (0’s and 1’s). With this convention you can send messages on a wire such as 10010101010… of any length. Your job is to develop a method to encode any message using only 0’s and 1’s. How would you design such a system?

Please try to answer this question in 1-2 paragraphs. Your answer should try and answer the following sub-questions.

1. How would you encode numbers using your convention?
2. Does your convention handle positive and negative numbers? If so, how?
3. Does your convention handle alphabets and words? If so, how?
4. What are the main limitations that you can think of the approach you came up with?

In my system, I will first focus on handling a moderate scope of positive and negative numbers by using the two’s complement notation. Each number will be represented by 16 bits. This would give a total range of -32767 to 32767. However, in order to handle alphabet letters and other characters, including a space character, I would assign 36 characters from 32731 to 32767 to represent those characters. For example, 0111 1111 1101 1011 would represent A, 0111 1111 1101 1100 would represent B, and so on until Z is reached, leaving 10 additional characters for operation symbols, spaces, tabs, etc. So for example, 0111 1111 1111 1111 could represent a space character. This approach has a few limitations. For one, only the English alphabet characters are encoded in this system. The scope is also not very large so huge numbers would not be able to be encoded. There could also be potential overflow errors if for example a message was sent that requested the solution to 32730 plus 3.

***Here is a sample answer to solve this challenge. There are no right and wrong answers and points will be awarded for originality rather than finding the right answer. So please make sure your answer is original rather than correct. The goal of this exercise is to make you think in terms of designing systems. Please read the below template on how to attempt answering this question. This is not a complete answer but provided to you as a reference*.**

**Sample Answer:**

In my system, I will be encoding the numbers and alphabets using a 16 bit sequence. Each message will be of length 32 and will be used to represent a number or a character.

For example, 0000 0000 0000 0000 would represent the number 0. The reason for choosing a length of 16 is as follows…..

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### Section B Fundamental Questions (55 points)

* (+3) In the binary number 10100000 what is the Most Significant Bit (MSB). 1 (leftmost bit) Chapter 1.2
* (+3) In the binary number 10100000 what is the Least Significant Bit (LSB). 0 (rightmost bit) Chapter 1.2
* (+3) How many bytes is 96 bits? 12 (8 bits in 1 byte) Chapter 1
* (+3) What is the result of the following AND operation on 8-bit numbers.

10101111

AND 01010010

------------- =

00000010

* (+3) What is the result of the following OR operation on 8-bit numbers.

10101111

OR 01010010

------------- =

11111111

* (+3) What is the result of the following XOR operation on 8-bit numbers.

10101111

XOR 01010010

------------- =

11111101

* (+3) Convert the following hexadecimal numbers into binary. (0x means number is hexadecimal)
  + 0xCD 11001101
  + 0x67 1100111
  + 0x1F 11111
* (+3) Convert the following 2’s complement numbers to it’s base 10 representations.
  + 01111 15
  + 10100 -12
  + 10000 -16
* (+3) How many numbers can be represented with a binary number 6 bits in length? 64 (2^6)
* (+3) What is the maximum number that can be represented by an 8 bit unsigned binary number?

255 ((2^8) – 1)

* (+3) What is the minimum number that can be represented by an 8 bit signed binary number?

-127 ((2^7) -1)

* (+3) Why is the 2’s complement system used? (Answer briefly) Subtraction can be performed using addition logic and negative numbers. Therefore, subtraction logic is not needed. Lecture 11 Video
* (+3) What are floating point numbers? How are fractions represented with binary numbers? (Answer briefly) Floating point numbers are numbers that contain floating decimal points. Fractions are represented with binary numbers by placing binary digits to the right of the binary point (powers of 2 are negative). Chapter 1
* (+3) What is the result of the following addition problem (using two’s complement notation)? Highlight your answer.

00001111 This is a positive integer

+ 10101010 Negative integer

A. 01100101 B. 10111001

C. 01010101 D. 10110101

* (+3) What is the result of the following subtraction problem (using two’s complement notation)?

00001111 positive integer

- 10101010 negative integer

A. 01100101 B. 10111001

C. 01010101 D. 10110101

* (+10) You have an image which is 2048 \* 2048 pixels. Each pixel is encoded using 3 bits. What is the size of the image in bytes and kilobytes (KB) and megabytes (MB)

1,572,864 bytes ((2048\*2,048 \*3) / 8)

1,536 KB (1,572,864 / 1,024)

1.5 MB (1,536 / 1,024)

Chapter 1

### Section C Exploration Challenge (15 points)

Please provide a short summary of your computer science background. You can answer ‘None’ if you do not have any background. I have taken one intro to Java programming class prior to this.

* What is the total memory in your computer (RAM)? 16 GB
* What is the size of the hard disk in your computer? N/A
* Is your main memory DRAM or SRAM? How? DRAM, SRAM max capacity is 16 MB

https://www.atpinc.com/blog/computer-memory-types-dram-ram-module

* What is the current generation of DRAM ? 16 GB DRAM
* Provide a comparison of the cost (in USD), size and the type of RAM from the 1960’s to 2020. You may create a table that shows these prices every 5 years. Please provide references of your exploration.
* Please provide some comments on how you think the computer memory has evolved over the years. Try and quantify your observations. )For example, you can analyze by saying something like this. The price of memory has fallen almost 1000x over 10 years while the capacity has gone up 10000x.)
* What is the unit of measuring RAM speeds? Megahertz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cost of RAM chip** | **Size of RAM chip** | **Memory Type** | **Speed**  **(nsec)** |
| 1960 | $5.00 | 0.00098 KB | IBM 1401 core memory | 11,500 |
| 1970 | $0.70 | .00098 KB | IBM 370/135 core memory | 770 |
| 1980 | $405.00 | 64 KB | N/A | N/A |
| 1990 | $851.00 | 8,192 KB | Bocaram AT 8 MB | N/A |
| 2000 | $99.89 | 65,536 KB | 64 MB DIMM PC-100 | N/A |
| 2010 | $69.99 | 4,194,304 KB | 2x 2GB DIMM DDR3-1066 | 7-7-7-20 |
| 2020 | $104.99 | 33,554,432 KB | 2x 16GB DIMM DDR4-2400 | 15-15-15-39 |

References (Please add your references below:

<https://jcmit.net/memoryprice.htm>

Based on the chart above, we can see that capacity has gone up by a factor of 10E12, where as the price has gone up by a factor of 15.

### Section D Programming Challenge (15 points)

This question will test your ability to research for solutions online. Please provide references to sources that you have used at the bottom of the question in a references section.

* Write a program in Python to add 2 numbers and print the result.
* You must provide either a source code file or a link to Google Colab that has the program.

https://colab.research.google.com/drive/1-EfJE1HG6pbztzkh\_FN2mfcDxLkiAnPG?usp=sharing

* How would you extend your code to add 2 numbers by getting an input from the user?

I would make two number variables and assign their values to pythons built in input function to obtain input from the user. Because this would return 2 strings, the float() function would be used to convert them into numbers, and then I would simply add the 2 numbers using the addition operator.

References (Please add your references below:

https://scanftree.com/programs/python/python-program-to-add-two-numbers/

**Instructions: Upload the file with the screenshot on Blackboard with your firstname\_lastname.docx**