## 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?

If it were a number, there would be a 0 at the start of the sequence and then a 1 would be the 10’s placeholder and then depending how many single digits there are in the number, determines the 0’s after the For example, 2 would be 0100 and 43 would be 011111000.

1. Does your convention handle positive and negative numbers? If so, how?

Positive integers would be like what I described about with the 01 meaning it is positive. A negative integer would have 2 0’s like 001 rather than one. For example, “-2” would be 00100 and “2” would be 0100. For “-43” the answer would be 0011111000.

1. Does your convention handle alphabets and words? If so, how?

The letters would be made up of all 0’s and it would range from 0 to 26. For example, “A” would be “0” and “B” would be “00.”

1. What are the main limitations that you can think of the approach you came up with?

I am not quite sure how well it would do with other symbols. It is a very restrictive approach to developing a simple code for messages. I don’t know very much about binary either so this one was tough to me.

***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).

The MSB is equal to 2^7 or 128. This is the bit that is farthest to the left of the binary number.

* (+3) In the binary number 10100000 what is the Least Significant Bit (LSB).

The LSB is the 0 to the farthest right. It is equal to 1.

* (+3) How many bytes is 96 bits?

1 byte = 8 bits

So 96/8 = 12 bytes

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

10101111

AND 01010010

The answer is 2 or 00000010

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

10101111

OR 01010010

The answer is 255 or 1 01000001 11101111

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

10101111

XOR 01010010

The answer is 253 or 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 numbers

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

255

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

-128

* (+3) Why is the 2’s complement system used? (Answer briefly)

It is easier for negative and positive numbers to be added together. 2’s complement is also pretty easy to understand to it used a lot. We mostly use 2’s complement system in signed binary number and operations. The arithmetic is also the same as unsigned binary numbers.

* (+3) What are floating point numbers? How are fractions represented with binary numbers? (Answer briefly)

A floating point number means it is a number with an inconsistent number of digits before and after the decimal. You put a decimal in the front of the bites to make it a fraction. So 0.1011 would be the exact same steps as an positive integer, but the exponent would be negative so the answer would be 0.6875 or 11/16.

* (+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)

768 \* 768 bytes which is 0.768 by 0.768 kilobytes which is 0.000768 by 0.000768

### 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.

* What is the total memory in your computer (RAM)?

16 GB

* What is the size of the hard disk in your computer?

1TB

* Is your main memory DRAM or SRAM? How?

It is DRAM. I know this because I built the computer myself and I know what goes into it. You can also base it off storage capacity because DRAM has so much more storage that SRAM.

* What is the current generation of DRAM ?

I found one Alliance Memory As4C DDR4 Synchronous DRAMs made in 2020.

* 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 10 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.)

The size of RAM has increased over 1711960816x from the 1960’s to the 2020’s from 0.00098 to 16777216. The cost of a ram chip dramatically increased in the 1980’s by about 579x from what is was in the 1960’s. The price fortunately dropped down to $47.99 in 2020. While the price has continued to trend mostly downward, the speed and size of the RAM chip has only increased.

* What is the unit of measuring RAM speeds?

megahertz

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cost of RAM chip** | **Size of RAM chip** | **Memory Type** | **Speed** |
| 1960 | 5.00 | 0.00098 | IBM 1401 core memory | 11500 |
| 1970 | 0.70 | 0.00098 | IBM 370/135 core memory | 770 |
| 1980 | 405.0 | 64 | S-100, SD Sales/Jade 64K Kit | 1000 |
| 1990 | 851.00 | 8192 | Bocaram AT 8MB - $149+72\*9.75 | 80 |
| 2000 | 99.89 | 65536 | 64 MB DIMM PC-100 @ $99.89 | 70 |
| 2010 | 77.99 | 4194304 | 2x 2GB DIMM DDR2-800 @ $41.99 + free shipping | 5-5-5-15 |
| 2020 | 47.99 | 16777216 | 2x 8GB DIMM DDR4-2400 @ $47.99 + free shipping | 17-17-17-39 |

References (Please add your references below:

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

### 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 Collab that has the program.
* How would you extend your code to add 2 numbers by getting an input from the user?

Add the input section so users can put in specific numbers.

References (Please add your references below:

<https://pythonguides.com/add-two-numbers-in-python/>

<https://www.programiz.com/python-programming/examples/add-number>

Google Collab:

<https://colab.research.google.com/drive/1Uxs3XBc18I6MMZdhT6-VTXRaMawcDMMB?usp=sharing>