ACS Applied Computer Science — The University of Winnipeg

APPLIED COMPUTER SCIENCE

ACS-2906-001
Computer Architecture and System Software

Fall 2024

Laboratory 2

Due date: September 18th, 11:59 pm **Total marks: 10**

Motivation

The goal of this laboratory is to reinforce number conversion concepts, and to introduce students to ASCII.

1. (2 marks) Binary to Decimal/Hexadecimal. Show all your work. Taking a photo of handwritten solutions is okay if it is easier for you. Assume that we are using unsigned integers.
   a. $(11\ 1010\ 1010)_2$ — 0011 1010 1010 → 3 A A — $2^9+2^8+2^7+2^5+2^3+2^1 = 938$
   b. $(01\ 1101\ 0101)_2$ — 0001 1101 0101 → 1 D 5 — $2^8+2^7+2^6+2^4+2^2+2^0 = 469$

2. (2 marks) Hexadecimal to Binary/Decimal. Show all your work. Taking a photo of handwritten solutions is okay if it is easier for you.
   a. $(AB2)_{16}$ — $(1010\ 1011\ 0010)_2$ — $10\cdot16^2 + 11\cdot16^1 + 2\cdot16^0 = 2,738$
   b. $(2F8)_{16}$ — $(0010\ 1111\ 1000)_2$ — $2\cdot16^2 + 15\cdot16 + 8\cdot16^0 = 760$

3. (2 marks) Decimal to Binary/Hexadecimal. Show all your work. Taking a photo of handwritten solutions is okay if it is easier for you.
   a. $(2023)_{10}$
   b. $(522)_{10}$

a) $2023 = 126\cdot16+7$
$126 = 7\cdot16+14 \Rightarrow (7E7)_{16}$
$7 = 0\cdot16+7$

b) $522 = 32\cdot16+10$
$32 = 2\cdot16+0 \Rightarrow (20A)_{16}$
$2 = 0\cdot16+2$

a) $2023 = 1011\cdot2+1$
$1011 = 505\cdot2+1$
$505 = 252\cdot2+1$
$252 = 126\cdot2+0$
$126 = 63\cdot2+0$
$63 = 31\cdot2+1$
$31 = 15\cdot2+1$
$15 = 7\cdot2+1$
$7 = 3\cdot2+1$
$3 = 1\cdot2+1$
$1 = 0\cdot2+1$
$(0111\ 1110\ 0111)_2$

b) $522 = 261\cdot2+0$
$261 = 130\cdot2+1$
$130 = 65\cdot2+0$
$65 = 32\cdot2+1$
$32 = 16\cdot2+0$
$16 = 8\cdot2+0$
$8 = 4\cdot2+0$
$4 = 2\cdot2+0$
$2 = 1\cdot2+0$
$1 = 0\cdot2+1$
$(0010\ 0000\ 1010)_2$

4. (4 marks) Write a sequence of instructions to swap the fourth and third bits in a byte (8 bits) x. For example, given the number $(1010\ 1010)_2$, the output should be:

answer is at the bottom of Paper

input	1	0	1	**0**	**1**	0	1	0
bit position	7	6	5	4	3	2	1	0
output	1	0	1	**1**	**0**	0	1	0

Note that the only positions that change are the third and fourth; the remaining ones do not.

You will need to use three masks: one for extracting the 4th position, another for extracting the third position, and another for extracting all positions except the 4th and 3rd positions. You may want to follow the following steps:

Hint:

- Use a mask and bit-wise logic operation to extract the bits at the fourth positions. Assign the result to a bit pattern y (i.e., $y = x * m$, where $*$ is the corresponding logical operator and m is the bit mask)
- Use a mask and bit-wise logic operation to extract the bits at thrid positions. Assign the result to a bit pattern z (i.e., $z = x * m$)
- Use a mask and bit-wise logic operation to extract the all the bits except those at the third and fourth positions. Assign the result to a bit pattern w (i.e., $z = x * m$)
- Shift y and z and combine the new bit patterns (think to which direction each bit vector should be shifted)
- Combine the two shifted bit patterns with w using a logical bit-wise operator.

For this question, right shift will be considered logical $(>>)$.

Please write all the sequence of instructions you used for reaching your solution.

Evaluation:

- You **must** show all your work for questions 1,2 and 3 to receive full marks. Also provide all the sequence of instructions for question 4.

Submission instructions

Include your name and student number in all files. Zip your file or files into one report named $StudentNumber\_Lab2.zip$, and submit it through Nexus. **Students that do not follow these instructions will lose 2 marks. Late submissions will not be accepted. NO EXCEPTIONS**.

1, get the 3rd Position $y = x \wedge 00001000$

2, get the 4th Position $z = x \wedge 00010000$

3, get all others $w = x \wedge 11100111$

4, shifting $y \gg 1$

$z \ll 1$

5, combine $(w \mid y) \mid z$