**CSC 325 Computer Architecture**

**Class 7 Homework**

**September 11, 2013**

**Arithmetic and Logic Support**

**Exercise 1**

This exercise is designed to give you more practice in counting in binary and converting between decimal and binary. Solve these problems *without the use of technology* (except a paper and pencil).

1.1 List the weights of the least significant eight bits in a binary number system.

20, 21, 22, 23, 24, 25, 26, 27 1, 2, 4, 8, 16, 32, 64, 128

1.2 Calculate (by hand) the decimal equivalent of each of the following unsigned binary numbers.

1. 10011011

155

1. 01110001

113

1. 11111111

255

1.3 Determine the decimal equivalent of each of the following signed binary numbers, assuming a 2s complement representation.

1. 10011011

-101

1. 01110001

113

1. 11111111

-1

Study the following approach to converting a decimal number into binary. Repeatedly divide the number by 2, noting the remainders, until the dividend equals 0. (2 goes into 28 fourteen times with a remainder of 0; etc.) Collect the remainders to get the binary representation.

2 | 28

| 14 0

0

1

1

Repeat

2 | 28

2 | 14 0

7 0

Repeat

2 | 28

2 | 14 0

2 | 7 0

3 1

Etc.

2 | 28

2 | 14 0

2 | 7 0

2 | 3 1

2 | 1 1

0 1 Here you can see that the dividend = 0, so collect the remainders, ordering the remainders from the bottom to the top in a left to right collection as seen below.

Producing 2810 = 1 1 1 0 02 . You can check your work: 24+23+22 = 16+8+4 = 28

1.4 What is the unsigned binary representation of each of the following decimal numbers? Use the repeated division approach to accomplish the conversion. (paper and pencil are easier than typing it). Convert each result to an eight bit number.

1. 45

101101

1. 128

10000000

1.5 What is the signed (2s complement) representation of each of the following decimal numbers, assuming an eight bit number?

1. -45

1010011

1. 127

01111111

1. 128

Has to be done in 9 bits

010000000

Check your work or practice using an online conversion tool, such as:

Binary::Decimal or Decimal::Binary

<http://acc6.its.brooklyn.cuny.edu/~gurwitz/core5/nav2tool.html>

If you find a good converter tool online, please post the link on Piazza with a summary of the functionality.

**Exercise 2**

Consider a four bit adder with CI and CO (in the LW library). Use two of these devices to implement an 8 bit adder. This is known as cascading the adders.

2.1 What is the range supported in an 8 bit unsigned context?

255 to 0

2.2 What is the range supported by an 8 bit 2’s complement system?

127 to -128

2.3 Assuming a 2’s complement system, complete the following table by observing the output sum of the cascaded adder on the operand conversions you provide.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Operation | Operand A A7A6A5A4A3A2A1A0 (addend) | Operand B B7B6B5B4B3B2B1B0  (augend) | Sum  S7S6S5S4S3S2S1S0 | Comments |
| 7 + 9 | 00000111 | 00001001 | 00010000 |  |
| -128 + -1 | 10000000 | 11111111 | (1)01111111 | There is a carry bit (9-bit) |
| -1 + -1 | 11111111 | 11111111 | 11111110 | There is a carry but it does not affect the answer |
| 127 + 10 | 01111111 | 00001010 | 10001001 |  |
| 24 + -30 | 00011000 | 11100010 | 11111010 |  |