CSC 256 – Machine Structures

Number Representations and Operations

Due: February 14th, 2017 @ midnight

Use the space below to complete the following questions. Make sure to show your work and to highlight your final answer either by bold text, change text color, or by highlighting the text. Each question is worth two (2) points each.

# Number Conversions

1. Convert 86 to 16-bit Two’s Compliment binary

|  |  |
| --- | --- |
|  | 86 |
| - | 64 |
|  | 22 |
| - | 16 |
|  | 6 |
| - | 4 |
|  | 2 |
| - | 2 |
|  | 0 |

0000|0000|0101|0110

1. Convert -123 to 16-bit Two’s Compliment binary

First convert +123 to binary…

0000|0000|0111|1011

Flip the bits

1111|1111|1000|0100

+ 1

1111|1111|1000|0101

1. Convert 23 to unsigned 16-bit binary

Unsigned, always positive… Just covert to binary…

0000|0000|0001|0111

1. Convert 2132 to unsigned hexadecimal

Unsigned always positive…

|  |  |  |  |
| --- | --- | --- | --- |
| 0000 | 1000 | 0101 | 0100 |
| 0 | 8 | 5 | 4 |
| Ans:0x854 |  |  |  |

1. Convert 2344 to Two’s Compliment hexadecimal

|  |  |  |  |
| --- | --- | --- | --- |
| 0000 | 1001 | 0010 | 1000 |
| 0 | 9 | 2 | 8 |
| Ans: 0x0928 |  |  |  |

1. Convert Two’s Compliment binary 1010101110 to decimal

|  |  |  |
| --- | --- | --- |
| 10 | 1010 | 1110 |
| 01 | 0101 | 0001 |
| + |  | 1 |
| 01 | 0101 | 0010 |
| 256+ | 64+16 | +2 |
| Equals= -338 |  |  |

1. Convert the unsigned binary number 111011000000 to decimal.

|  |  |  |
| --- | --- | --- |
| 1110 | 1100 | 0000 |
| 3587+ | +192 | +0 |
| Ans: 3776 |  |  |

1. Convert the unsigned hexadecimal value 0x4564fabc to decimal

|  |  |
| --- | --- |
| (16^7)\*4+ |  |
| (16^6)\*5+ |  |
| (16^5)\*6+ |  |
| (16^4)\*4+ | Ans: 1,164,245,692 |
| (16^3)\*15+ |  |
| (16^2)\*10+ |  |
| (16^1)\*11+ |  |
| (16^0)\*12 |  |

Each hexadecimal is represented by 4 bits, so each hex value is converted into its value then multiplied by 16 to whatever power its at. Once each value has been multiplied they’re summed together to achieve the final answer…

1. Convert the unsigned hexadecimal value 0x5642cccc to decimal.

|  |  |
| --- | --- |
| (16^7)\*5+ |  |
| (16^6)\*6+ |  |
| (16^5)\*4+ |  |
| (16^4)\*2+ | Ans: 1,447,218,380 |
| (16^3)\*12+ |  |
| (16^2)\*12+ |  |
| (16^1)\*12+ |  |
| (16^0)\*12 |  |

1. Convert the unsigned hexadecimal value 0xffffffff to a decimal.

|  |  |
| --- | --- |
| (16^7)\*15+ |  |
| (16^6)\*15+ |  |
| (16^5)\*15+ |  |
| (16^4)\*15+ | Ans: 4,294,967,295 |
| (16^3)\*15+ |  |
| (16^2)\*15+ |  |
| (16^1)\*15+ |  |
| (16^0)\*15 |  |

I would normally assumed -1, but… its unsigned?

1. Convert the Two’s Compliment binary number to decimal, 01011011

|  |  |
| --- | --- |
| 0101 | 1011 |
| 80+ | 11 |
| Ans: 91 |  |

1. Convert the One's Compliment binary number to decimal, 11011111

|  |  |
| --- | --- |
| 1101 | 1111 |
| 0010 | 0000 |
| -32 |  |

Why -32? Because the last bit is 1.

1. Convert the One's Compliment binary number to decimal, 01000011

|  |  |
| --- | --- |
| 0100 | 0011 |
| 64+ | 3 |
| Ans:67 |  |

Why not flip bits? Last bit wasn’t 1.

1. Convert the Two’s Compliment binary number to decimal, 01000001

|  |  |
| --- | --- |
| 0100 | 0001 |
| 64+ | 1 |
| Ans: 65 |  |

# Number Operations Subtract and Addition

All numbers are Two’s Complement binary numbers.

1. Add the binary numbers 10101101 and 00101111, or add 10101101 to 00101111

|  |  |
| --- | --- |
| (carried bits row) 0001 | 1111 |
| 1010 | 1101 |
| +0010 | 1111 |
| Ans: 1101|1100 |  |

Highlighted values note carried bits on those values.

1. Add the binary numbers 10111101 and 11111111, or add 10111101 to 11111111

|  |  |
| --- | --- |
| (Carried bits row)1011 | 1110 |
| 1011 | 1101 |
| +1111 | 1111 |
| Ans:11011|1100 |  |

Extra bit….

1. Add the binary numbers 10001001 and 00000000, or add 10001001 to 00000000

|  |  |
| --- | --- |
| 1000 | 1001 |
| +0000 | 0000 |
| Ans:1000|1001 |  |

1. Add the binary numbers 11111101 and 10101010, add 11111101 to 10101010.

|  |  |
| --- | --- |
| 1111 | 1101 |
| +1010 | 1010 |
| Ans: 11010|0111 |  |

Extra bit…

1. Subtract the two’s complement binary numbers 10111111 and 01010101, or subtract 01010101 from 10111111.

|  |  |
| --- | --- |
| (Carry Bits)0100 |  |
| 1011 | 1111 |
| -0101 | 0101 |
| Ans: 0110 | 1111 |

Highlighted values signify carry bits replacing zeros (NOTE: When the carry bits reach their destination I realize the 1’s cancel out and the extra one drops down), the red signifies the value being carried

1. Subtract the two’s complement binary numbers 10000001 and 00110011, or subtract 00110011 from 10000001.

|  |  |
| --- | --- |
| (Carry Bits)  0111 | 1110 |
| 1000 | 0001 |
| -0011 | 0011 |
| Ans:0100 | 1110 |

Highlighted values signify carry bits replacing zeros (NOTE: When the carry bits reach their destination I realize the 1’s cancel out and the extra one drops down), the red signifies the value being carried

1. Subtract the two’s complement binary numbers 11111111 and 00001111, or subtract 00001111 from 11111111

|  |  |
| --- | --- |
| 1111 | 1111 |
| -0000 | 1111 |
| Ans: 1111 | 0000 |

1. Subtract the two’s complement binary number 10101011 and 11110000, or subtract 11110000 from 10101011

|  |  |
| --- | --- |
| (Carry bits)0111 | 0000 |
| 1010 | 1011 |
| -1111 | 0000 |
| 1011 | 1011 |
| (flip bits)0100 | 0100 |
|  | +1 |
| Ans: -0100 | 0101 |

Highlighted values signify carry bits replacing zeros (NOTE: When the carry bits reach their destination I realize the 1’s cancel out and the extra one drops down), the red signifies the value being carried

1. Add the two’s complement hexadecimal numbers 0x21321abc and 0x00000ffa, or add 0x00000ffa to 0x21321abc.

|  |  |
| --- | --- |
| (Carry bits)0000 | 1110 |
| 2132 | 1abc |
| +0000 | 0ffa |
| Ans: 0x2132 | 2ab6 |

Why are the carry bits 1? Because they exceed the value of 16. When a value such as A(10) is added to C(12) you’ll get 22 which you then subtract 16 from which will equal 6. Logically each carry bit then represents a 16 but you only add 1 to the next hex value.

1. Subtract the two’s complement hexadecimal numbers 0x01321fff and 0x112233ff, or subtract 0x112233ff from 0x01321fff.

|  |  |
| --- | --- |
| (Carry bits)(0)(16)(18)(0) | 0(19)00 |
| 1122 | 33ff |
| -0132 | 1fff |
| Ans:-ff01400 |  |

Why is the value negative? Because the leading value is between 8 and F. Carry bits are put in “()” so that you can see which bit is being added to what.