California State University,   
Monterey Bay

Week 1 – Homework

Homework 1

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Computer Architecture*

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**Exercise 1**

* Convert 2 numbers “a” and “b” into binary numbers.
* Add them in binary form.
* Convert the result back into a decimal number.

a: 23734

b: 12195

|  |  |
| --- | --- |
| Number | Binary |
| 23734 | 0101 1100 1011 0110 |
| 12195 | 0010 1111 1010 0011 |

**Conversion using division by 2:**

|  |  |  |  |
| --- | --- | --- | --- |
| Division by 2 | Remainder | Division by 2 | Remainder |
| 23734 / 2 | 0 | **12195 / 2** | 1 |
| 11867 / 2 | 1 | **6097 / 2** | 1 |
| 5933 / 2 | 1 | **3048 / 2** | 0 |
| 2966 / 2 | 0 | **1524 / 2** | 0 |
| 1483 / 2 | 1 | **762 / 2** | 0 |
| 741 / 2 | 1 | **381 / 2** | 1 |
| 370 / 2 | 0 | **190 / 2** | 0 |
| 185 / 2 | 1 | **95 / 2** | 1 |
| 92 / 2 | 0 | **47 / 2** | 1 |
| 46 / 2 | 0 | **23 / 2** | 1 |
| 23 / 2 | 1 | **11 / 2** | 1 |
| 11 / 2 | 1 | **5 / 2** | 1 |
| 5 / 2 | 1 | **2 / 2** | 0 |
| 2 / 2 | 0 | **1 / 2** | 1 |
| 1 / 2 | 1 |  |  |

**Addition in Binary:**

|  |
| --- |
| 0101 1100 1011 0110 |
| 0010 1111 1010 0011 |
| **1000 1100 0101 1001** |

**Conversion to decimal:**



1000 1100 0101 1001 = 35929

**Exercise 2**

The 32 bit hexadecimal number 12A012FF is in little endian format.

* Convert it to a binary number with the help of an online “hex to bin” converter.
* Convert it to a decimal signed (!) integer number.

STEP 1 – Convert “little endian” format to binary using online converter

Online converter located at <http://www.binaryhexconverter.com/hex-to-binary-converter>

Results

|  |  |
| --- | --- |
| 12 | 0001 0010 |
| A0 | 1010 0000 |
| 12 | 0001 0010 |
| FF | 1111 1111 |

Which is .. 1111 1111 0001 0010 1010 0000 0001 0010

STEP 2 – Convert binary to decimal signed Integer Number

Now convert 1111 1111 0001 0010 1010 0000 0001 0010 to signed decimal

1. This the number is negative as the left most bit is ‘1’
2. Now convert to from 2 compliment…

1111 1111 0001 0010 1010 0000 0001 0010 Original number with sign

0000 0000 1110 1101 0101 1111 1110 1101 1s compliment (reverse 1s and 0s)

+1 Add 1

0000 0000 1110 1101 0101 1111 1110 1110 2s compliment

Now convert binary to decimal and remember negative



1. Thus converting the binary to decimal signed integer number results in a -155590

**Exercise 3**

Convert “-34.78125” into the float IEEE 754 format.

The format for IEEE 754 is

|  |  |
| --- | --- |
| Bits | Value |
| 1 | Sign |
| 8 | Exponent |
| 23 | Fraction/mantissa |

1. First set the sign bit, since the number is negative
2. Convert integer part (34) to binary

|  |  |
| --- | --- |
| Division by 2 | Remainder |
| 34 / 2 | 0 |
| 17 / 2 | 1 |
| 8 / 2 | 0 |
| 4 / 2 | 0 |
| 2 / 2 | 0 |
| 1 / 2 | 1 |

Result: 100010

1. Convert fraction part (.78125) to binary through multiplication by 2 (like in video)

|  |  |
| --- | --- |
| Mulitply by 2 | Remainder |
| .78125 x 2 = 1.5625 | 1 |
| .5625 x 2 = 1.125 | 1 |
| .125 x 2 = 0.25 | 0 |
| 0.25 x 2 = 0.5 | 0 |
| 0.5 x 2 = 1 | 1 |

Result: 11001

1. Add the two results and adjust them

Result: 100010 + .11001 = 100010.11001

Shift 5 to left to get in 1.xxx format

Result: 1.0001011001

1. Exponent is 5, which must have 127 added for bias and convert to binary

Result: 5 + 127 = 132

|  |  |
| --- | --- |
| Division by 2 | Remainder |
| 132 / 2 | 0 |
| 66 / 2 | 0 |
| 33 / 2 | 1 |
| 16 /2 | 0 |
| 8 / 2 | 0 |
| 4 / 2 | 0 |
| 2 / 2 | 0 |
| 1 / 2 | 1 |

Result: 1000 0100

1. Combine all the terms and pad with zeros…

|  |  |  |
| --- | --- | --- |
| Bits | Value |  |
| 1 | Sign | 1 |
| 8 | Exponent | 1000 0100 |
| 23 | Fraction/mantissa | 1.0001011001 |

Note that the “1.” is dropped from the final results

|  |  |  |
| --- | --- | --- |
| Sign | Exponent | Fraction (padded)… |
| 1 | 1000 0100 | 0001 0110 0010 0000 0000 000 |

Result: 11000010000010110001000000000000