

California State University,
Monterey Bay

Week 1 – Homework
Homework 1

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CST337

Computer Architecture

Summer 2016

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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:**

32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1	
2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
1	0	0	0	1	1	0	0	0	1	0	1	1	0	0	1	
32768	0	0	0	2048	1024	0	0	0	64	0	16	8	0	0	1	35929

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 converterOnline 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 2s 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

8388608	4194304	2097152	1048576	524288	262144	131072	65536	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1	
2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
1	1	1	0	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	
8388608	4194304	2097152	0	524288	262144	0	65536	0	16384	0	4096	2048	1024	512	256	128	64	32	0	8	4	2	0	15556590

3) 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

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

Multiply 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

4. 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

5. 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

6. 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