Study Questions and Answers

Binary representation

1. What is the ASCII representation for CHUD :
    a. hexadecimal
    b. binary

   C = 43
   H= 48
   U = 55
   D = 44
   In binary : 0100 0011 0100 1000 0101 0101 0100 0100

2. Represent the following decimal numbers in **both** binary sign/magnitude and two's complement using 16 bits.
   + 512
   - 29

   Sign Magnitude:
   512 = 0000 0010 0000 0000
   -29 = 1000 0000 0001 1101
   Two's Complement:
   512 = 0000 0010 0000 0000
   -29 = 1111 1111 1110 0011

3. Represent the following two's complement values in decimal:

   1101011

   Since this starts with a leftmost 1, it is a negative number. The magnitude of the negative number is determined by flipping the bits and adding 1:

   0010100 + 1 = 0010101

   This is 21, so the original value was -21.

   0101101

   Since this starts with a leftmost 0, it is a positive number and we just compute the magnitude as an unsigned binary number, which is 45.

4. Represent the following in two's complement using 5 bits and perform the addition. Indicate if there is a carry, an overflow, or both.

6 + 4

6 = 00110
4 = 00100

```
        00110
+       00100
        -------
        01010        There is no carry and no overflow
```

6 + - 6

6 = 00110
-6 = 11010

```
        00110
+       11010
        -------
1       00000        There is a carry of 1 and no overflow
```

-12 + - 4

12 = 01100
-12 = 10100
4 = 00100
-4 = 11100

```
        10100
+       11100
        -------
1       10000        There is a carry of 1 and no overflow.
```

Note that we can represent -16 but not +16 using 5 bits.

5. Represent the following decimal values using the IEEE 754 single precision floating point representation. For each value, show the representation in binary scientific notation form, show the bit patterns in the IEEE 754 representation, and show the hexadecimal representation of the IEEE 754 representation.

+54

54 in binary is 110110.
Converted to binary scientific notation, this is $1.10110 * 2^5$
Sign bit = 0
Biased Exponent = 127 + 5 = 132

132 in binary is 10000100
Mantissa with the hidden bit is 10110

Putting these together gives us:
0 10000100 10110000000000000000000

In groups of four this is 0100 0010 0101 1000 0000 0000 0000 0000
Which is 4258000 in hex.

-0.875

0.875 in binary is 0.111
which is 1.11 * 2^{-1} in binary scientific notation
Sign bit = 1 (negative)
Biased Exponent = 127 + -1 = 126
126 in binary is 01111110
Mantissa with the hidden bit is 11

Putting these together gives us:
1 01111110 11000000000000000000000

In groups of four this is;

1011 1111 0110 0000 0000 0000 0000 0000

Which is BF60000 in hex.

6. Given the following hex that represents an IEEE 754 single precision value, give the decimal value.
   0xC1200000

C1200000 converted to binary is:
1100 0001 0010 0000 0000 0000 0000 0000

Sign bit = 1
Biased Exponent = 10000010
Mantissa (with hidden 1) = 1.01

In decimal, the biased exponent is 130.
130 = 127 + actual, so the actual exponent is 3

This means our value is 1.01 * 2^3 or 1010

This is equal to 10

But don't forget we had a negative sign bit, so the value is really -10