CISS 100 Numbering Systems

Base	Prefix	# of Symbols	Range	Digits & Ordering
Decimal	0d	10	0-9	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Binary	0b	2	0-1	0, 1
Hexadecimal	0x	16	0-F	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

Positional Values

Decimal

Power	10^3	10^2	10^1	10^0	Smallest Value = 0d0
Pos Value	1000's	100's	10's	1's	Largest Value = 0d9999
Example	9	9	9	9	

Binary

Power	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Smallest Value =0d0
Pos Value	128's	64's	32's	16's	8's	4's	2's	1's	Largest Value = 0d255
Example	1	1	1	1	1	1	1	1	0b11111111 = 0d255

Hexadecimal

Power	16^1	16^0	Smallest Value =0d0
Pos Value	16's	1's	Largest Value = 0d255
Example	F	F	0xFF = 0d255

How do we count in decimal?   Digits 0-9

100's   10's   1's

Algorithm in pseudocode
Start w/ 0 and always work right to left (least significant to more significant po

If Curr == 0, 1, 2, 3, 4, 5, 6, 7, or 8
            Next <= Curr +1
Else if Curr == 9 (9 is last in ordered sequence)
            Next <= 0 and Carry 1 to next higher positional place

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How do we count in binary?   Digits 0, 1

8's   4's   2's   1's

Algorithm in pseudocode
Start w/ 0 and always work right to left (least significant to more significant positional places)

If Curr = 0
          Next <= Curr +1
Else if Curr == 1 (1 is last in ordered sequence)
          Next <= 0 and Carry 1 to next higher positional place

How do we count in hexadecimal?   Digits 0-9, A-F   Algorithm in pseudocode
                                                                  Start w/ 0 and always work right to left (least significant to more significant positional pla

          16's   1's

                     0   If Curr == 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E
                     1   Next <= Curr +1
                     2   Else if Curr == F (F is last in ordered sequence)
                     3   Next <= 0 and Carry 1 to next higher positional place
                     4
                     5
                     6
                     7
                     8
                     9
                     A
                     B
                     C
                     D
                     E
                     F
          1 0

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Decimal - 0d	Binary - 0b	Hexadecimal - 0x
0	0	0
1	1	1
2	10	2
3	11	3
4	100	4
5	101	5
6	110	6
7	111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Binary to Decimal   Algorithm - write out binary positional values, fill in binary value in table and add positions where there is a 1

Example Convert 0b10110011 to Decimal

									1
Pos Values	128's	64's	32's	16's	8's	4's	2's	1's	2
0b10110011	1	0	1	1	0	0	1	1	16
									32
									128
									0d179

Try - 0b011000101

Pos Values	128's	64's	32's	16's	8's	4's	2's	1's

Decimal to Binary   Algorithm

1. Write out binary positional values
2. Moving left to right,
3. Deterimine largest common denominator (LCD)
Example 0d199   4. Record a 1 in LCD positional value
5. Subtract LCD from Decimal number
6. Using difference goto 2 and continue

Pos Value	128's	64's	32's	16's	8's	4's	2's	1's
	1	1	0	0	0	1	1	1

7. When complete fill in 0s where there are no 1's

Decimal Example
Consider extracting individual digits in decimal ex 0d7432
Divide by 1000 to get 7 with remainder of 432
Divide remainder by 100 to get 4 with remainder of 32
Divide remainder by 10 to get 3 with remainder of 2
Divide remainder by 1 to get 2

199 - 128 = 71
71 - 64 = 7
No 32's 16s or 8s so these will be 0s
7 - 4 =3
3 - 2 = 1
1 - 1 =0   Solution 0b11000111

Try 0d117

Pos Value	128's	64's	32's	16's	8's	4's	2's	1's

Binary Hexadecimal

Decimal - 0d Binary - 0b xadecimal - 0x

Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

Algorithm
1. Count to Binary and Hexadecimal Side by Side
2. Use table to convert 4 binary digits to hexadecimal digit and vice versa

Examples
0b10110111 to 0xB7 (1011 is B and 0111 is 7)

0xAD to 0b10101101

Why does this work? Look at positional values
Binary

128's	64's	32's	16's	8's	4's	2's	1's
1	1	1	1	1	1	1	1

Hexadecimal

16's	1's