Lab 01

Worksheet 01B

Base Conversion

Feel free to refer back to Lecture 01 for additional assistance.

Expanded positional notation is a sum of terms of the form:

$$\text{value} \times \text{base}^{\text{position}}$$

Below is a table for converting between decimal, hex, octal, and binary:

TABLE 1 Hexadecimal, Octal, and Binary Representation of the Integers 0 through 15.

Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Octal	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
Binary	0	1	10	11	100	101	110	111	1000	1001	1010	1011	1100	1101	1110	1111

- To convert a number of base b to decimal (base 10), expand the base b number using positional notation, then calculate the sum.
- To convert from decimal to another base b, divide n by b repeatedly until the quotient q is zero, and take the remainders. This is the "systematic" method.
- Decimal to binary conversion is easier with the nonsystematic "powers of 2" method:
  1. Find the largest power of 2 less than the number you wish to convert (e.g., $2^k < n$).
  2. Subtract that number $(n - 2^k)$.
  3. Add a 1 in the corresponding place in the binary string.
  4. Repeat.

For reference, below are the first 16 powers of two:

2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	2^8	2^9	2^{10}	2^{11}	2^{12}	2^{13}	2^{14}	2^{15}	2^{16}
1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536

To convert from binary to octal or hexadecimal, simply group the bits of the binary number into groups of 3 or 4, respectively. Then, convert each group into the corresponding digit using the table provided above.

Binary to Decimal Conversion

(1)

Convert 1011_2 to decimal using expanded positional notation. Show your work.

(2)

Convert the following binary number to octal. Show your work.

0 1 0 1 1 1 0 0 1 0 1 1 1 0 1 0 1 0 1 0 0 1 1 0

(3)

Convert the same binary number to hexadecimal. It is provided again for your convenience. Show your work.

0 1 0 1 1 1 0 0 1 0 1 1 1 0 1 0 1 0 1 0 0 1 1 0

Decimal to Binary Conversion

(4)

Convert 248_{10} to binary using the systematic method (repeated division). Show your work.

(5)

Convert 248_{10} to binary using the nonsystematic method (powers of 2). Show your work.

(6)

Convert 248_{10} to hexadecimal *directly* using the systematic method (repeated division). Show your work.

(7)

Convert 248_{10} from binary to hexadecimal using the conversion table. Isn't this easier?

(8)

Convert 248_{10} from binary to octal using the conversion table.

Challenges

C1

Below is a conversion table for base 64,[1] which uses essentially every character found on a standard keyboard. It is useful for encoding images into text, which is common on the internet and for email attachments.

Index	Binary	Char	Index	Binary	Char	Index	Binary	Char	Index	Binary	Char
0	000000	A	16	010000	Q	32	100000	g	48	110000	w
1	000001	B	17	010001	R	33	100001	h	49	110001	x
2	000010	C	18	010010	S	34	100010	i	50	110010	y
3	000011	D	19	010011	T	35	100011	j	51	110011	z
4	000100	E	20	010100	U	36	100100	k	52	110100	0
5	000101	F	21	010101	V	37	100101	l	53	110101	1
6	000110	G	22	010110	W	38	100110	m	54	110110	2
7	000111	H	23	010111	X	39	100111	n	55	110111	3
8	001000	I	24	011000	Y	40	101000	o	56	111000	4
9	001001	J	25	011001	Z	41	101001	p	57	111001	5
10	001010	K	26	011010	a	42	101010	q	58	111010	6
11	001011	L	27	011011	b	43	101011	r	59	111011	7
12	001100	M	28	011100	c	44	101100	s	60	111100	8
13	001101	N	29	011101	d	45	101101	t	61	111101	9
14	001110	O	30	011110	e	46	101110	u	62	111110	+
15	001111	P	31	011111	f	47	101111	v	63	111111	/

Convert the following binary number into base 64. Show your work.

000011100001010000010001010110101101010010100101110100010000010001001110 0

C2

Convert the following number to base 4 using the nonsystematic method, but with powers of 4 instead of powers of 2. Show your work.

$$3\,044\,998\,776_{10}$$

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1. https://en.wikipedia.org/wiki/Base64↩