Lecture 1 (08.25.2025)

bit : 1 or 0

8 bits = 1 byte (4 bits = "nibble")

Binary : $2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
$128\ 64\ 32\ 16\ 8\ 4\ 2\ 1$

2^{10} = 1 Kilobyte 2^{30} = 1 Terabyte

2^{20} = 1 Megabyte 2^{40} =

2^{30} = 1 Gigabyte

$2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
$128\ 64\ 32\ 16\ 8\ 4\ 2\ 1$
44_{10} = 0 0 1 0 1 1 0 0

73_{10} = 1001001

$44 - 32 = 12$, $12 - 8 = 4$, $4 - 4 = 0$

$73 - 64 = 9$, $9 - 8 = 1$, $1 - 1 = 0$

Repeated Division Method:

2	73	
2	36	1
2	18	0
2	9	0
2	4	1
2	2	0
2	1	0
	0	1

converts any decimal # to different base forms

1001001

2	73	
2	36	1
2	18	0
2	9	0
2	4	1
2	2	0
2	1	0
	0	1

= 1001001 ✓

binary → decimal

1001001

$1 \cdot 2^6 + 1 \cdot 2^3 + 1 \cdot 2^0$

$= 64 + 8 + 1$

$= 73$ ✓

2's complement

For representation of negative numbers

_ _ _ _ _ _ _ _

↑ sign bit (0 ≡ positive , 1 ≡ negative)

example. 23

	—	64	32	16	8	4	2	1
23 =	0	0	0	1	0	1	1	1
flip	1	1	1	0	1	0	0	0
								+1
-23 =	1	1	1	0	1	0	0	1

convert to negative:
flip the bits and add 1

Binary arithmetic :

		+	x
0	0	0	0
0	1	1	0
1	0	1	0
1	1	10	1

Hexadecimal number system

4 bits

_ _ _ _

8 4 2 1

0	0000	9	1001
1	0001	A	1010
2	0010	B	1011
3	0011	C	1100
4	0100	D	1101
5	0101	E	1110
6	0110	F	1111
7	0111		
8	1000		

convert binary → hexadecimal

0001 0110 0011 0100 1001 1100 1101

1 6 3 4 9 3 C D

$= 1634\,93CD_{16}$

convert hexadecimal → binary

B1FD = 1011 0001 1111 1101

octal number system

3 bits

4 2 1

0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

convert binary → octal:

1 100 011 100 111 01 = 61635 ✓

6 1 6 3 5

convert octal to binary:

472_8 = 100 111 010

conversion practice (for quiz)

decimal = base 10
hexadecimal: 16
octal: 8
binary: 2

Binary → octal

4 2 1

0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

$111110_2 = 76$ (7 6)

$1011001_2 = 131$ (1 3 1)

$1111111_2 = 177$ (1 7 7)

$100001 = 41$

$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 4 \cdot 8 = 32$

$1 \cdot 2^5 + 0 \cdot 2^4 + 0 \cdot 2^3 + 0 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0$

$= 2^5 + 2^0 = 32 + 1 = 33_{10}$

decimal conversion

octal → binary

$567_8 = 101\ 110\ 111$

$32_8 = 011\ 010 = 011010$

8 bits = 1 byte
4 bits = 1 nibble

$1001_8 = 001\ 000\ 000\ 001 = 1\,000\,000\,001$

include leading 0s

decimal → binary

$34_{10} \rightarrow ?_2$

2 | 34		
2 | 17	0	
2 | 8	1	
2 | 4	0	
2 | 2	0	
2 | 1	0	
	0	1

$= 100010_2$ ✓

octal → decimal

$111\ 110 =$

$8 + 6 = 14$
$14 + 16 = 30$

$1 \cdot 2^5 + 1 \cdot 2^4 + 1 \cdot 2^3 + 1 \cdot 2^2 + 1 \cdot 2^1 + 0 \cdot 2^0$

$= 32 + 16 + 8 + 4 + 2$

$= 62_{10}$ ✓

76_8 ✓

$100010_2 = ?_{10} = 1 \cdot 2^5 + 1 \cdot 2^1 = 32 + 2 = 34$ ✓

binary$_2$ → hexadecimal$_{16}$

0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

$\overline{8}\ \overline{4}\ \overline{2}\ \overline{1}$ } 0–15, 16 total

111011010 = 1DA ✓

1 D A

1DA = ~~000~~111011010

= 111011010 ✓