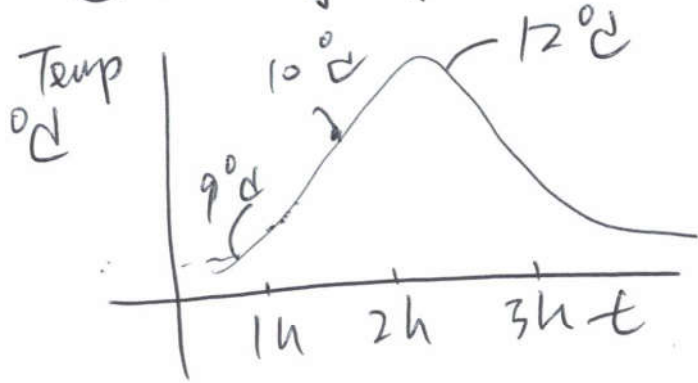
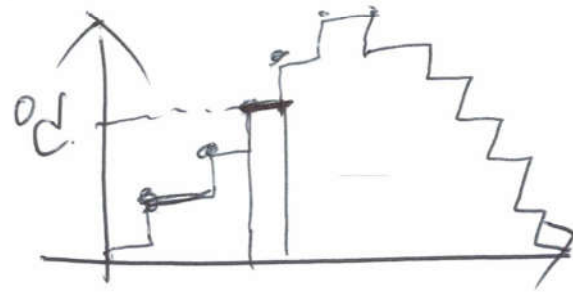
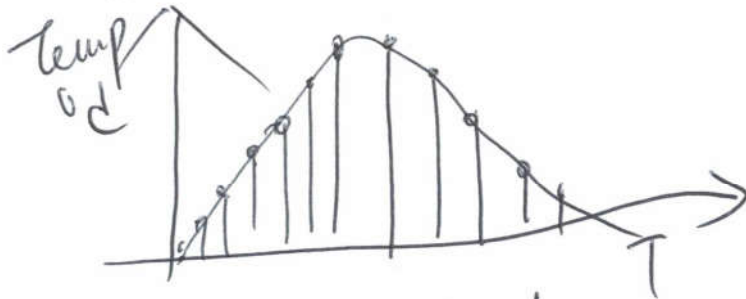


Binary Number Systems

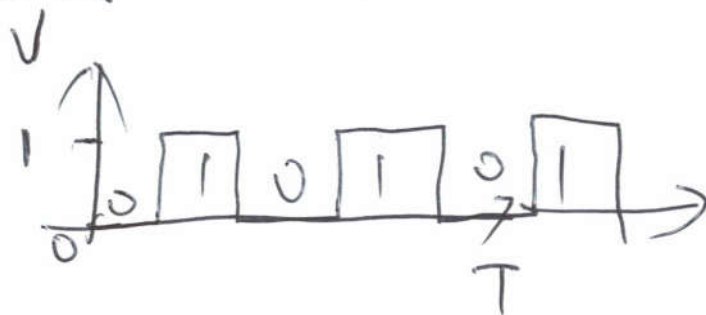
① Analog Signal



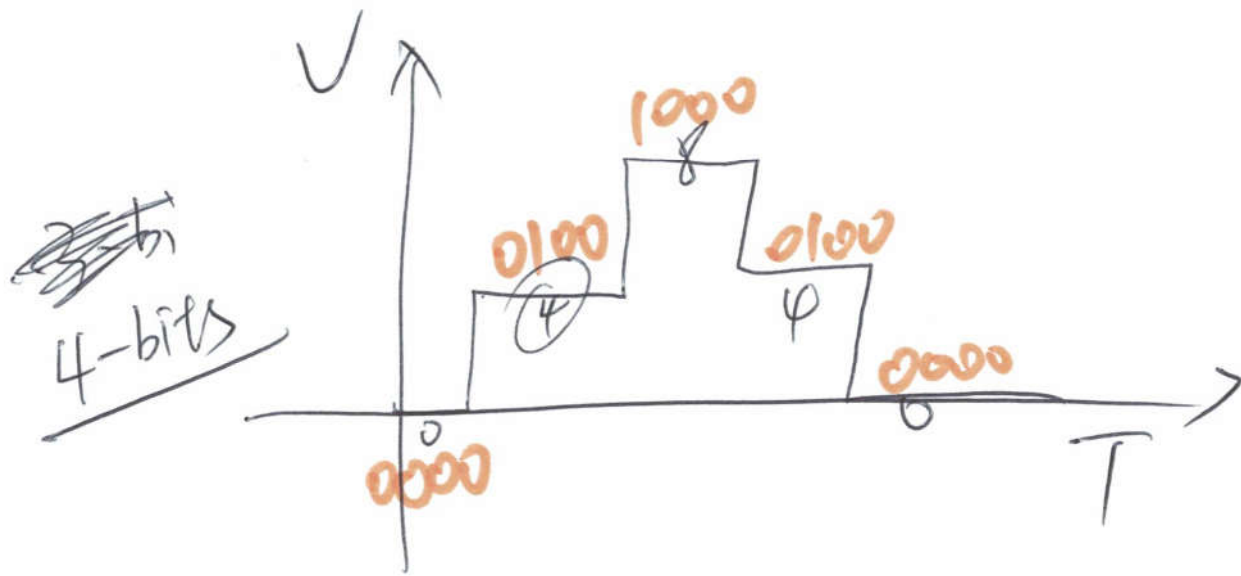
② Discrete time Signal



③ Digital Signals



0000 (B)	0 (D)
0001 (B)	1 (D)
0010 (B)	2 (D)
0011 (B)	3 (D)
0100 (B)	4 (D)



$$\begin{array}{r} 1000 \quad 8 \\ \hline 10000 \quad 16 \\ \hline 100000 \quad 32 \end{array}$$

$$1024_{(10)} = 1 \times 10^3 + 0 \times 10^2 + 2 \times 10^1 + 4 \times 10^0$$

$$1024_{(2)} = \begin{array}{cccccccccccc} \boxed{1} & \boxed{0} & \boxed{2} & \boxed{4} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} \\ 2^{10} & 2^9 & 2^8 & 2^7 & 2^6 & 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 & \end{array}$$

Why using digital numbers for computers



- ① Reliable
- ② only 1 or 0.

△ Binary \rightarrow Decimal

$$\begin{array}{ccccccc} 1 & 0 & 1 & 0 & | & & \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & & \\ 2^4 & 2^3 & 2^2 & 2^1 & 2^0 & & \end{array} \rightarrow 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$
$$= 16 + 0 + 4 + 0 + 1 = \underline{21}$$

$$(10101)_2 \rightarrow (21)_{10}$$

$$\begin{array}{ccccccc} 1 & 0 & 1 & 0 & | & . & 1 & 1 & \\ \hline \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow \\ 2^0 & 2^{-1} & 2^{-2} & & & & & & \end{array} = 21 + 2^{-1} + 2^{-2} = 21 + 0.5 + 0.25$$
$$= (21.75)_{10}$$

△ 10101
MSB \leftarrow most significant Bit
 \rightarrow LSB least significant Bit

③

$$(11110)_2 \rightarrow 1x2^4 + 1x2^3 + 1x2^2 + 1x2^1 + 0x2^0$$

△ Decimal \rightarrow Binary

① By Eye:

$$(13)_{10} \rightarrow \text{IIIIIIII}$$

$$(18326)_{10} \rightarrow \boxed{100} \text{ embarrassing}$$

② Calculation:

$$(100101)_2 \rightarrow (37)_{10}$$

2	37	<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">1</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">1</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">1</div> <div style="border: 1px solid black; border-radius: 50%; padding: 2px 5px; margin-right: 5px;">0</div> </div> <div style="margin-left: 10px;"> <p>LSB \rightarrow</p> <p>MSB</p> </div>
2	18	
2	9	
2	4	
2	2	
2	1	
2	0	
0		

0	1	0	0	1	0	
				↓	↓	
						32 + 4 + 1 = 37

$$2(100101)_2 = 10(37)_{10}$$

$$\text{③ } 037 \rightarrow 37$$

Δ Fractional → Binary

$(25.625)_{10} \rightarrow (\quad)_2$

2	25	
2	12	1
2	6	0
2	3	0
2	1	1
2	0	1
	0	0

↑

011001

↓ ↓ ↘
16+8 + ~~1~~ = 25

$2^{-1} \quad 2^{-2} \quad 2^{-3}$
↑ ↑ ↑

0.625

0.001101

1/2	0.625	
1/2	0.375	1
1/2	0.1875	0
1/2	0.09375	1
1/2	0.046875	0
	0	0

↓

11001.101

8

$$(0.875)_{10} \rightarrow (0.111)_2$$

$\downarrow \quad \downarrow \quad \downarrow$
 $0.5 + 0.25 + 0.125 = 0.875$

$\frac{1}{2} 0.875$	1
$\frac{1}{2} 0.75$	1
$\frac{1}{2} 0.5$	1
$\frac{1}{2} 0.0$	0

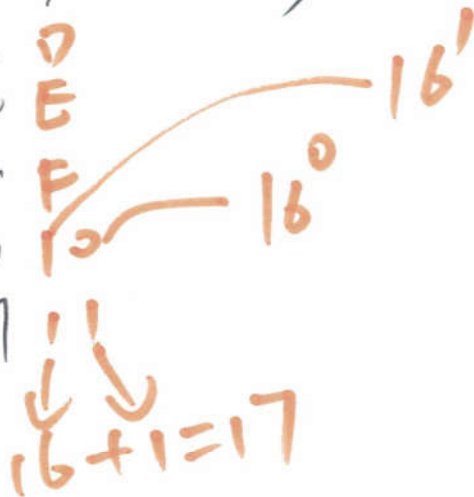
Hexadecimals (Base 16)

1
2
3
4
5
6
7
8
9
10
11
12

1
2
3
4
5
6
7
8
9
A
B
C

13
14
15
16
17

D
E
F



(6)

$$\begin{array}{r}
 \cancel{7} \\
 16 \overline{) 757} \\
 \underline{16 \overline{) 47}} \quad 5 \\
 \underline{16 \overline{) 2}} \quad 15 \\
 \underline{16 \overline{) 0}} \quad 2 \\
 0 \quad 0
 \end{array}$$

$$(757)_{10} \rightarrow (2F5)_{16}$$



$$\begin{array}{r}
 1/16 \overline{) 0.25} \\
 \underline{1/16 \overline{) 0.016}} \quad 4 \\
 \underline{1/16 \overline{) 0.256}} \quad 0 \\
 \underline{1/16 \overline{) 0.096}} \quad 4 \\
 \underline{1/16 \overline{) 0.536}} \quad 1 \\
 0.8576 \quad (8)
 \end{array}$$

$$(757.25)_{10}$$

$$\rightarrow (2F5.404)_{16}$$

↓ ↓ ↓ ↓ ↘
 אסא טסאס טסאס טסאס טסאס

