2024/08/07

Digital Circuits

Complement system

$\boxed{7|1|5} - \boxed{8|9|7}$ × not allowed

(−500) to (+499)

$\boxed{3|1|5} - \boxed{4|9|7}$

$= 315 - 497 + z - z$

$= 315 + (z - 497) - z$

Choose → $z = 1000$

$(z - \text{number}) \geq 500$

$= 315 + 503 - 1000$

$= 818 - 1000$ } 818 in our system $= -182$

$= -(1000 - 818)$

You need not perform this subtraction if you choose $z \rightsquigarrow$ max count + 1

$\boxed{4|0|0} + \boxed{2|0|0}$

$= 600$ overflow

Binary	Decimal
000	0
001	1
010	2
011	3

+ve numbers are represented as it is

2's complement

100	-4	2's complement
101	-3	-ve numbers $\rightarrow$ $-d = \underbrace{2^n}_{\text{number of bits}} - d$
110	-2	
111	-1	

n-bits in 2's complement representation :- -2^{n-1} to $2^{n-1}-1$

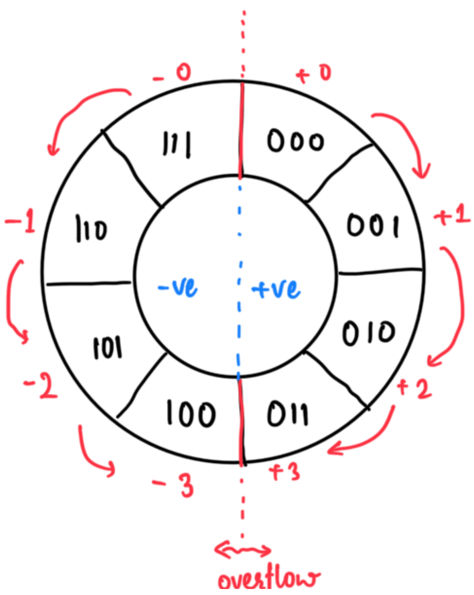
1's complement system :-

Binary	Decimal
000	0
001	1
010	2
011	3
100	-3
101	-2
110	-1
111	0

$\rightarrow$ Positive number $d \rightarrow d$

Negative number $(-d)_2 = 2^n - 1 - d$

$\boxed{\text{Overflow}}$



$$\{1, 0, \underbrace{\ldots}_{\text{operators}}\} \longrightarrow \text{Boolean Algebra}$$

Switching Algebra

Memory
↓
Device operates on past data (or future samples)

Next lecture :- Axioms of Boolean Algebra

Doubts in Assignment pls

2024/08/08

* Axioms

(i) $B = 0$ if $B \neq 1$, [Binary]

$B = 1$ if $B \neq 0$

(ii) $\bar{1} = 0 \xrightarrow{\text{dual}} \bar{0} = 1$ [Complement] NOT operator

(iii) $0 \cdot 0 = 0 \xrightarrow{\text{dual}} 1 + 1 = 1$ [AND/OR operator]

(iv) $1.0 = 0 \xrightarrow{\text{dual}} 0 + 1 = 1$ "

(v) $1.1 = 1$, $0 + 0 = 0$ "

Theorems

(i) $A \cdot 1 = A$, $A + 0 = A$ [Identity]

(ii) $A \cdot 0 = 0$, $A + 1 = 1$ [Null element]

(iii) $A \cdot A = A$, $A + A = A$ [Idempotency]

(iv) $\bar{\bar{A}} = A$ [Involution]

(v) $A \cdot \bar{A} = 0$, $A + \bar{A} = 1$ [Complement]

(vi) $A \cdot B = B \cdot A$ [Commutation]

(vii) $(A \cdot B) \cdot C = A \cdot (B \cdot C)$ [Associativity]

(viii) $(A \cdot B) + (A \cdot C) = A \cdot (B + C)$, [Distributivity]

$(A + B) \cdot (A + C) = A + (B \cdot C)$

(ix) $A \cdot (A + B) = A$, $A + A \cdot B = A$

– set theory

[Covering theorem]

$$
\begin{aligned}
& A \cdot (A + B) \\
&= A \cdot A + A \cdot B \\
&= A \cdot 1 + A \cdot B \\
&= A (1 + B) \\
&= A \cdot 1 = A
\end{aligned}
$$

(x) $A \cdot B + A \cdot \bar{B} = A$, [Combining]

$(A + B) \cdot (A + \bar{B}) = A$

(xi) $(A \cdot B) + \bar{A} \cdot C + B \cdot C$

$= B \cdot A + B \cdot C + \bar{A} \cdot C$

(xii) $\overline{A \cdot B \cdot C} = \bar{A} + \bar{B} + \bar{C}$ [De Morgan's Theorem]

$\overline{A + B + C} = \bar{A} \cdot \bar{B} \cdot \bar{C}$

See EE1202 – W03 for the proof of (xi).

Digital Circuits :

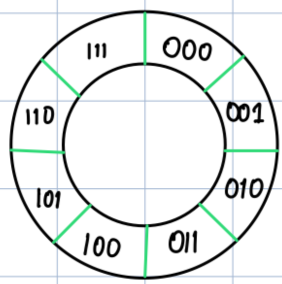
2024/08/05 – Lecture 4

Binary Number System

```
   1 1 0
 - 0 1 0
 -------
   1 0 0
```

```
   1 1 1
   ~1 ~1 0
 - 1 1 1
 -------
 - 1 1 1
```

borrow from 4^{th} bit → inconsistent result



most significant bit ← [| |] → least significant bit

↓

can be used as sign bit

$$\begin{bmatrix} 0 & \rightarrow & +ve \\ 1 & \rightarrow & -ve \end{bmatrix}$$

* Signed number representation

Binary	Decimal
000	+ 0
001	+ 1
101	− 1
⋮	⋮

n bits (no sign bit)

↓

0 to $2^n - 1$

n bits (1 sign bit)

$-2^{n-1} + 1 \leftarrow 0 \rightarrow 2^{n-1} - 1$