It is branch of electronic that deals with study of digital signals & components that use or create them

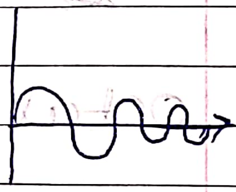
Digital Electronics

Number System :→

It is important ~~from~~ that how data are represented before they can be processed by any digital system including digital computer.

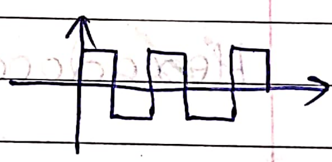
Analog Signal :-

Analog signals represents data through continuous values.



Digital Signal :→

It employ discrete values (usually binary) to represent information.



NS :- The decimal number system with which we are all familiar Known as (radix) of 10 i.e 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
independent digit

* Binary (radix) 2 :- i.e 0 & 1
octal (radix) 8 —
hexadecimal radix/base - 16

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3586.256

$10^3 \; 10^2 \; 10^1 \; 10^0$

$3586 = 3\times10^3 + 5\times10^2 + 8\times10^1 + 6\times10^0$

$10^{-1} \; 10^{-2} \; 10^{-3}$

$0.256 =$

$2\times10^{-1} + 5\times10^{-2} + 6\times10^{-3}$

✳ Binary Number system :-

128 32 16 8 4 2 1

$2^{\phi}, 2^{0} . 2^{-1} \; 2^{-2}$

0	0000
1	0001
2	0010
3	0011
9	1001

8 1
8 1
+1

Octal Number System :-

$8^{\phi}, 8^{0} . 8^{-1}$ integer

0
1
2
3
4
5
6
7

Hexadecimal Number system :-

$16^{\phi} \; 16^{0} . 16^{-1} \; 16^{-2}$

0
1
2
3
4
5
6
7
8
9
A 10
B 11
C 12
D 13

conversion :->

Digital equivalent of given number in another number system is given by sum of all digit multiplied by their respective place values. i.e B → D, O → D, HD → D

☆ B → D)

$$(1001.0101)_2 -$$

$$2^3\times1+2^2\times0+2^1\times0+1\times2^0+0\times2^{-1}+1\times2^{-2}+0\times10^{-3}+1\times10^{-4}$$

$$8+0+0+1+0+0.25+0+0.0625$$

$$9+0.3125$$

$$(9.3125)_{10}$$

☆ octal to Decimal $(137.21)_8$

$$8^2\times1+3\times8^1+7\times8^0+2\times8^{-1}+1\times8^{-2}$$

$$64+24+7+2\times\frac{1}{8}+1\times\frac{1}{8^2}$$

$$95+0.265$$

$$(95.265)_{10}$$

☆ Hecadecimal → Decimal $(1E0.2A)_{16}$

$$1\times16^3+14\times16^2+0\times16^1+2\times16^{-1}+10\times16^{-2}$$

$$480+0.164$$

$$(480.164)_{10}$$

~~Switching circuit~~ :-

Representation of (-) Binary number

2 | 13
2 | 6 — 1
2 | 3 — 0
1 — 1

Sign-Bit magnitude :-

It represent (+) & (-) decimal number,

·375 × 2 = 0.75
0.75 × 2 = 1.5
0.5 × 2 = 1

In 8 bit representation

8 4 2 1

00001001 +9

10001001 -9

1's complement :- 1's

1001
0110
+1
0111

1010
0101
+1
0110

(+) number remain unchanged & (-) number are obtained by taking the 1's complement of (+) counterparts.

+9 00001001

-9 11110110

1010111

0101000

invert

2's complement :-

find 1's comp +1

1010110 → 0101001

invert

+1

Ans

M T W T F S S

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4821
+5 1001

9's complement :->

It is used to find the substraction of decimal number.
(−) number from 9

~~1423~~
~~9999~~
~~16~~

10's complement :-

~~It is decamial number~~
It is found by adding 1 to the 9's complement of that decamial number.

9's: 9999
1423 (−)
8576
10's: + 1

① 456

9's comp | 10's comp

999
−456
543

543
+1
544

2's complement addition.

0110 → 1001, +1 → 1001 ①

1011 → 0100, +1 → 0101 ②

Add (1 + 2)

1001
0101
1110 2's

invert 0001
+1

2's complement addition:-

Add 1010 0101

1	invert	0101	1010
2's 2	+1	+1	+1
		0110	1011

+7 − 4 = +3

0111 0111 invert

−(1)100 1011

1001 1,0010

0010

+1

0011 +3

0110

\+ 1011

Discard (1) 0001 ~~2's comp~~

invert 1110

\+ 1

$\boxed{1111}$ 2' Comp Add

1's complement number addition

we first find 1's complement of (−) number

1101 and $\boxed{-1001}$ → 1's comp.

(+1100)$_2$ & +(0001)$_2$

(12)$_{10}$ + (1)$_{10}$

Scom

0110

\+ 1101

(1)0011

1100

0001

1101

0|1101

0011

\+ 1

0100

(+3) (+2)

0011

0010

0101 (+5)

(+7) + (−4)

0111

0100

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Example

1) B → D

$(100101)_2$

Ans $(37)_{10}$

$(1101)_2$

Ans $(13)_{10}$

D → B

2	10	0
2	5	1
2	2	0
	1	1

1010

$(3289)_{10} \to (\quad)_2$

2	3289	1
2	1644	0
2	822	0
2	411	1
2	205	1
2	102	0
2	51	1
2	25	1
2	12	0
2	6	0
2	3	1
	1	1

$(\cancel{110011011001})$

$(110011011001)_2$

0+0=0   0-0=0

0+1=1   1-0=1

1+1=10   1-1=0

1+1+1=11   10-1=1

D → B 0.6875

0.6875 × 2 = 1.375   1

0.375 × 2 = 0.75   0

0.75 × 2 = 1.5   1

0.5 × 2 = 1   1

(.1011)

0.634 $\xrightarrow{Ans}$ 0.1010001

39.12

2	39	1
2	19	1
2	9	1
2	4	0
2	2	0
	1	1

.12×2 = 0.24   0

0.24×2 = 0.48   0

0.48×2 = 0.96   0

0.96×2 = 1.92   1

.92×2 = 1.84   1

0.84×2 = 1.68   1

0.68×2 = 1.36   1

terminated

$(100111.0001111)_2$

HD → B

7 B F

0111 1011 1111

B → H

1110 1001

E 9

HD → D

E 7 F 6

$14 \times 16^3 + 7 \times 16^2 + 15 \times 16^1 + \ldots$

$(59382)_{10}$

D → HD

16	5390	14
16	336	0
16	21	5
	1	1

150E

$0+0 = 0$

$0+1 = 1$

$1+1 = 10$

$1+1+1 = 11$

O → D

1054

$1 \times 8^3 + 0 \times 8^2 + 5 \times 8^1 + 4 \times 8^0$

~~(100110110011)~~

(10011011 $(556)_{10}$

D → O

8	574	6
8	71	7
8	8	0
	1	1

$(1076)_8$

O → B

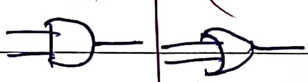
(7 1)

$(111 \quad 001)_2$

B → O

001 001 101 · 101 100

$(115 \cdot 54)_8$



AND

A·B

0
0
0
1

OR

A+B

0
1
1
1

NOT

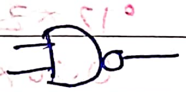
0 → 1

1 → 0

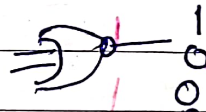
A → $\bar{A}$

NAND

1
1
1
0



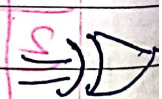
NOR

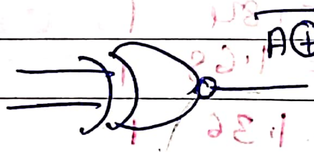


1
0
0
0

XOR

$A\bar{B} + \bar{A}B$





$\overline{A \oplus B}$

$AB + \bar{A}\bar{B}$

A	B	$\overline{A \oplus B}$
0	0	
0	1	0
1	0	0

$(111000 \cdot 111001)$

②

logical algebra

Boolean Algebra & its Application

Boolean Algebra is an algebra in which the variable's value are in the form of truth table, true (1) & false (0).

Boolean Algebra operations

$\cdot$	① Conjuction / AND operation	$\cdot$ $\wedge$
$+$	② Disjunction / OR operation	$+$ $\vee$
$\bar{A}$	③ Negation / Not operation	$\neg$

Boolean Algebra Truth Table

A	B	$A \wedge B$	$A \vee B$	$\neg A$
T 1	T 1	T 1	T 1	F 0
T 1	F 0	F 0	T 1	F 0
F 0	T 1	F 0	T 1	T 1
F 0	F 0	F 0	F 0	T 1

Law of Boolean Algebra

① Commutative Law :-

It states that changing the sequence of the variables does not have any affect on the output of a logic circuit.

$$A \cdot B = B \cdot A$$

$$A + B = B + A$$

② Associative Law :- It states that order in which the ~~(A+B)~~ logic operation are performed is irrelevant as their effect is same.

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

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

③ Distributive Law :-

$$A \cdot (B + C) = \overset{AB + AC}{(A \cdot B) + (A \cdot C)}$$

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

c) $A + A'B = A + B$

④ AND Law :- It use AND operation

$A \cdot 0 = 0$

$A \cdot 1 = A$

$A \cdot A = A$

$A \cdot \bar{A} = 0$

Indempotence
$A + A = A$
$AA = A$

Absorption
$A + AB = A$
$A(A + B) = A$

Redu

⑤ OR Law :- It use OR operation

$A + 0 = A$

$A + 1 = 1$

$A + A = A$

$A + \bar{A} = 1$

Complementary la
$A + A' = 1$
$AA' = 0$

⑥ Inversion Law :- It state that Double Inversion of variab result in original value.

$$\bar{\bar{A}} = A$$

★ Boolean Algebra Theoream :- It include

(2)

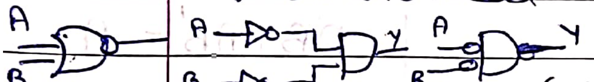
① De Morgan's first Law

② De Morgan's second Law

It is used to change the expression from one form to another form.

First Law :-

It States that complement of the product of variable = sum of their individual complement of variable

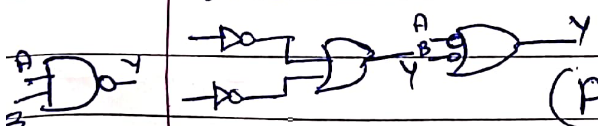


$$(A \cdot B)' = A' + B'$$

A	B	A·B	(A·B)'	A'	B'	A'+B'
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

Second Law :-

It State that complement of the sum of variable is equal to product of their individual complement of variable.



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

A	B	A+B	(A+B)'	A'	B'	A'·B'
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

Question

1) What is meant by Boolean Algebra ?

2) What are some application of BA ?

In electrical & electronic circuit, It is used to simplify & analyze the logical or digital circuit.

→ For increased reliability & decreased cost of manufacture

★ Simplification theoream :-

$AA' = 0$	$A + AB = A$	$AB + AB' = A$
$\cancel{BB' = B'}$	$A + \bar{A}B = A + B$	$(A+B)(A+B') = A$
$A' + 1 = A'$	$(A+B)(A+C) = A + BC$	$A(A+B) = A$
		$(A+B)B = AB$

Theoream for multiplying out & factoring

$\cancel{(X+Y)}$

(1) $(A+B)(A'+C)$ replace + with •

$AB + A'C$

(2) $AB + A'C$

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

Chapter 2

Complementing Boolean Expression :-

Q $AB + BC' + A'C + ABC$

Ans comp $(AB + BC' + A'C + ABC)'$

$(AB)' + (BC')' + (A'C)' + (ABC)'$ multiplying out

replace with +

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

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

$(A'B' + A'C + B'B' + B'C) \cdot (AA' + AB' + AC' + C'A' + C'B' + C'C')$

$(A'B' + A'C + B' + B'C)(AB' + AC' + A'C' + B'C' + C')$

→ $A'B'AB' + A'B'AC' + A'B'A'C' + A'B'B'C' + A'B'C'$
$+ A'CAB' + A'CAC' + A'CA'C' + A'CB'C' + A'CC'$
$+ B'AB' + B'AC' + B'A'C' + B'B'C' + B'C'$
$+ B'CAB' + B'CAC' + B'CA'C' + B'CB'C' + B'CC'$

→ $A'B'A'C' + A'B'B'C' + A'B'C + \cancel{A'CC'} + B'AB' + B'AC'$
$+ B'A'C' + B'C' + B'CAB'$

Remove duplicate

→ $A'B'C' + A'B'C' + A'B'C' + B'A + AB'C' + A'B'C' + B'C' + CAB'$

$A'B'C' + (AB'C' + AB'C) + AB' + B'C'$
$A'B'C' + AB' + AB'(C' + C) + B'C'$
$A'B'C' + AB' + AB' + B'C'$
$A'B'C' + AB' + B'C'$

$AB' + B'C'(A' + 1)$
$AB' + B'C'$
$B'(A + C')$

Codes.

In coding, when number or letter are represented by a specific group of Symbols, i.e the number / letter is encoded. The group of symbol is called code or binary code.

Binary code
1. weighted code
   unweighted code

weighted code :- If code has positional weights, then called as WC

1. positively WC
2. (–) WC

☆ Binary codes for Decimal digit

4-2-1
2-1

Digit	Natural BCD code 8421	unnatural BCD code 2421	84-2-1	Excess 3
0	0000	0000	0000	0011
1	0001	0001	0111	0100
2	0010	0010	0110	0101
3	0011	0011	0101	0110
4	0100	0100	0100	0111
5	0101	1011	~~0101~~ 1011	1000
6	0110	1100		1001
7	0111	1101		1010
8	1000	1110		1011
9	1001	1111		1100