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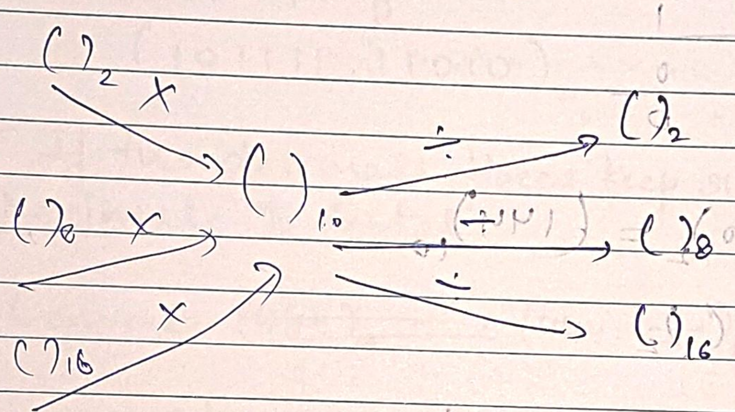
Date: 5/8/24

DLD

Number System

1) Decimal $\rightarrow ()_{10} \rightarrow 0-9$
2) Binary $\rightarrow ()_2 \rightarrow 0,1$
3) Octal $\rightarrow ()_8 \rightarrow 0-7$
4) Hexadecimal $\rightarrow ()_{16} \rightarrow$ ~~0-9~~ 0-F (0-9 & A-F)



Q Convert $(53)_{10}$ to $()_2$

2	53	
2	26	1
2	13	0
2	6	1
2	3	0
	1	1

$(53)_{10} = (110101)_2$

Q ~~Covert~~ Convert $(144)_{10}$ to $()_2$

2	144	
2	72	0
2	36	0
2	18	0
2	9	0
2	4	1

Q Convert $(144)_{10}$ to $(?)_2$

2	144	
2	72	0
2	36	0
2	18	0
2	9	0
2	4	1
2	2	0
	1	0

$(10010000)_2 = (144)_{10}$

\# $(0.5)_{10} \to (\,.\,)_2$

$0.5 \times 2 = 1.00$ 1

$0.00 \times 2 = 0\,0$ 0

$(0.5)_{10} = (0.10)_2$

Q $(0.625)_{10} \to (\,.\,)_2$

$0.625 \times 2 = \cancel{1.35 \to 1}$ $1.25 \to 1$

~~0.75~~ $\cancel{0.75 \to 0}$ $0.5 \to 0$

$\cancel{1.5 \to 1}$ $1.0 \to 1$

1    $0.0 \to 0$

$\Rightarrow (0.625)_{10} = (0.1010)_2$

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Q Convert $(47.8125)_{10}$ to $( )_2$

2	47	
2	23	1
2	11	1
2	5	1
2	2	1
	1	0

$0.8125 \times 2 = 1.625 \rightarrow 1$
$1.25 \rightarrow 1$
$0.5 \rightarrow 0$
$1.0 \rightarrow 1$
$0 \rightarrow 0$

$(101111.11010)_2$

\# If the decimals places keep repeating end it at 4-5 decimals

Decimal to Octal

Q Convert ~~$(444)_{10}$~~ $(444.456)_{10} \rightarrow ( )_8$

8	444	
8	55	4
8	6	7
	0	6

$0.456 \times 8 = 3.648 \rightarrow 3$
$5.184 \rightarrow 5$
$1.472 \rightarrow 1$
$3.776 \rightarrow 3$
$6.208 \rightarrow 6$
$1.664 \rightarrow 1$

674.351361

Q Convert $(235)_{10}$ To $( )_{16}$

16	235	
16	14	B

$(235)_{10} = (EB)_{16}$

Binary to Decimal

$(1010)_2 \to (\ )_{10}$

$1(2^3) + (0)(2^2) + 1(2^1) + (0) \times (2^0)$

Q. Convert $(1011110)_2 \to (\ )_{10}$

$\cancel{2+4+8+64}$ $2+4+8+16+64$
$= 94$

Q. $(1275)_8 \to (\ )_{10}$

$\Rightarrow \cancel{5 + 7(64) + 7(8^2) + 8^3}$
$5 + 7(8) + 2(64) + 512$
$= 701$

Q. $(A27B)_{16} \to (\ )_{10}$

$11 \cancel{+0} + 112 + 512 =$
$= \cancel{41,595}$ $= 41,595$

Q. $(1010)_2 \to (\ )_{10}$

$0\times1 + 1\times2 + 0\times4 + 1\times8$

Q. $(32.12)_8 \to (\ )_{10}$

$2(1) + 3(8) = 26.15625$

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Q $(AF23.75)_{16} \rightarrow (\ )_{10}$

$3(1) + 2(16) + \cancel{15} \ 15(16^2) + \cancel{A} \ 10(16^3)$

$= 44835.45703125$

Q $(2356.25)_{10} \rightarrow (\ )_2$

2	2356	
2	1178	0
2	589	0
2	294	1
2	147	0
2	73	1
2	36	1
2	18	0
2	9	0
2	4	1
2	2	0
2	1	0

$0.25 \times 2 = 0.5 \rightarrow 0$

$1.0 \rightarrow 1$

$0.0 \rightarrow 0$

1.00100110100.010

Q $(5623.123)_{10} \rightarrow (\ )_{16}$

16	5623	
16	351	7
16	21	F
	1	5

$0.123 \times 16 \rightarrow 1.968 \rightarrow 1$

$15.488 \rightarrow 15 \rightarrow F$

$7.808 \rightarrow 7$

$12.928 \rightarrow C$

15F7.1F7C

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Q $(0\cancel{110}110.1110)_2 \rightarrow (\ )_{10}$, $0.5 + 0.25 + 0.125$

$0(1) + 1(2) + 1(4) + 0(8) + 1(16) + 0(32) + 0(64)$

$= 2 + 4 + 16 + \cancel{32}$

$22\cancel{56}.875$

Q $(7252)_8 \rightarrow (\ )_{10}$

$2(1) + 5(8) + 2(64) + 7(8^3)$

$= 3754$

<u>Binary to Octal</u>

$00(1010100)_2 \rightarrow (124)_8$

4 2 2^0 4 2 1 2^2 2^1 2^0

421 421 421

$(001\ 010\ 100)_2$

Q Convert $(111011101.10111)_2 \rightarrow (\ )_8$

011 101 101 101 110

4 2 1 4 2 1 4 2 1 4 2 1 4 2 1

$(355.56)_8$

Q $(127.652)_8 \rightarrow (\ )_2$

$(001010111.110101010)_2$

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Q $(2x)_8 = (34)_8$

$2\times 8 + x(1) = \cancel{3(2)}\ 3(8) + 4(8^0)$

$16 + x = 24 + 4$

$x = 12$

Q $(211)_x = (152)_8$

$\cancel{2(64) + 8 + 1} = 1(64) + 5(8) + 2$

$= 106$

$2(x^2) + x + 1 = 106$

$2x^2 + x = 105$

$2x^2 + x - 105 = 0$

$49(2) + 7 - 105$

$\Rightarrow 98 + 7 - 105 = 0$

Q Determine ~~of~~ or radix of number in each operation

(i) $(\sqrt{41})_{b_1} = (5)_{b_2}$

$\sqrt{4(b) + 1} = 5$

$\Rightarrow \cancel{4 + 6(b_1)}\ 4(b^1) + 1 = \cancel{(25)_b}\ 25(b^0)$

$= 4b + 1 = 25$

$\Rightarrow 4b = 24$

$\Rightarrow b = 8$

Q $23 + 44 + 14 + 32 = 223$

$\Rightarrow 2(b) + 3 + 4(b) + 4 + 1(b) + (3)(b) + 2 + 4$
$= 2(b^2) + 2(b) + 3$

$\Rightarrow 10b + 13 = \cancel{2b^2 + 2b + 3}\ \cancel{223}\ 2b^2 + 2b + 3$

$\Rightarrow \cancel{10b}\ 8b + 9 = 2b^2$

$\Rightarrow 2b^2 - 8b + 10 = 0$

$b^2 - 4b - \cancel{10}\,5 = 0$

$b^2 - 5b + 1b - 5 = 0$

$b(b - 5) + 1(b - 5) = 0$

$\Rightarrow (b + 1)(b - 5)$

$\Rightarrow b = 5, -1$

Arithmetic Operator

- Add^n
- Sub^n
- Mult^n
- Division

Binary Addition

Q

```
 1111
 10111
 01101
------
100100
```

```
 111111 1
 ~~010111101~~
 ~~101110001~~
 ~~1010111110~~
```

```
 010011101
 1011100
```

```
 0 1 0 1 1 1 1 0 1      010111101
 1 0 1 1 1 0 0 0 1      101110001
 ~~1 1 1 1 0 1 1 0~~    0110
           1 0 1 1 0
```

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Subtraction

Q Subtract 0110 from 1010

$$\begin{array}{r} \cancel{1}010 \\ -\ 0110 \\ \hline 0100 \end{array}$$

Signed & Unsigned No.s

Unsigned (+ve)

A	B	C	3bit
0	0	0	→ 0
0	0	1	→ 1
0	1	0	→ 2
0	1	1	→ 3
1	0	0	→ 4
1	0	1	→ 5
1	1	0	→ 6
1	1	1	→ 7

Range → $(0 \text{ to } 2^n - 1)$

Signed (+ve, -ve) 1 → -ve, 0 → +ve

A	B	C	3bit
0	0	0	→ 0
0	0	1	→ 1
0	1	0	→ 2
0	1	1	→ 3
1	0	0	→ 0
1	0	1	→ -1
1	1	0	→ -2
1	1	1	→ -3

Range $(-(2^n)+1 \text{ to } 2^n - 1)$

Binary to Hexa decimal

Ex $(1010\ 0110)_2 \rightarrow (?)_{16}$

8421 8421

$\Rightarrow (A6)_{16}$

Q Convert $(1111\ 0011\ 0101)_2 \rightarrow (\ )_{16}$

8421 8421

$(F\ 3\ 5)_{16}$

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Q Convert $(BA37.25)_{16} \rightarrow (\ )_2$

$(1011\ 1010\ 0011\ 0111 . 0010\ \cancel{00}\ 0101)_2$

1s Compliment

$(1010)_2 \rightarrow 0101$

2's complement

$1010 \rightarrow$ ~~1010~~ 0101

$+\ 1$

0110

Q 000110101

$\rightarrow$ 0111001010

+1

111001011

Subtraction using 1's compliment

Q Use 1's compliment method to perform A-B where A = 1010, B = 1001

Ans 1's compliment of B = ~~10~~ 0110

Adding A and 1's compliment = ~~1001~~

1010

+ 0110

0000

+ 1

0001

If carry is generated it will be added

If carry is not generated 2 take 1's complement. 2 add -ve ahead of it.

Q Subtract 1010 from 1000 by 1's compliment

A = 1000
B = 0101

A + B = 1000
+ 0101
1101 ⟹ 0010

Ans ⟹ $-(0010)_2$

Q Find the binary equivalent of −18 if the number is represented in
(i) sign magnitude
(ii) 1's compliment
(iii) 2's compliment

2	18	
2	9	0
2	4	1
2	2	0
	1	0

$-(10010)_2$

⟹ 00010010 → 18
⟹ 10010010 → −18

00010010 → 11101101 (1's compliment)
+1
11101110 (2's compliment)

Q. $(54)_{10} - (87)_{10}$ use 1's compliment method.

2	54	
2	27	0
2	13	1
2	6	1
2	3	0
	1	1

$(110110)_2$

2	87	
2	43	1
2	21	1
2	10	1
2	5	0
2	2	1
	1	0

$(1010111)_2$

~~0 0 1 0 0 0 1~~

```
  110110
+ 0101000
  1011110
  ~~0111111~~
  0100001
```

$= (0100001)_2$

Subtraction using 2's compliment

Step I Take 2's compliment of the second no.
Step 2 Add the two
Step 3 If carry generated discard it.
Step 4 If carry isn't generated Take 2's compliment of the answer.

Q ~~1001 from~~ 1010 − 1001

```
  0110
+    1
  0111
+ 1010
  0001
```

Q Subtract 1000 − 1010

```
  0101
+    1
  0110
+ 1000
  ~~1111~~
  ~~0111~~
  1110
  0001
+    1
−(0010)_2
```

Q (235) − (324)

2	235	
2	117	1
2	58	1
2	29	0
2	14	1
2	7	0
2	3	1
	1	1

$(11101011)_2$

2	324	
2	167	0
2	83	1
2	41	1
2	20	1
2	10	0
2	5	0
2	2	1
	1	0

~~(101001110)~~$_2$

```
  ~~010110001~~
+          1
  ~~010110010~~
+ ~~111~~
```

2	324	
2	162	0
2	81	0
2	40	1
2	20	0
2	10	0
2	5	0
2	2	1
	1	0

101000100

```
  11101011
 010110010
 110011101
```

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Q. Adding $-(20)_{10}$ & $-(18)_{10}$ using 1's compliment

2	20	0
2	10	0
2	5	0
2	2	1
	1	0

$18 \rightarrow (10010)_2 = (00010010)$
$= ~~(10010010)~~$
$~~(01101)~~_2 = (11101101)$

$(10100)_2 \Rightarrow ~~(01011)_2~~ = (00010100)$
$~~= (10010100)~~$
$\Rightarrow (11101011)$

~~01011~~
~~+ 01101~~
~~101000~~

  11101011
+ 11101101
  111011000
+   1
  111011001

$\rightarrow$ 11011001 1's
(00100110)

844

Q. $(23.BD.59)_{16} \rightarrow ( )_8$

$(00010\ 0011\ 1011\ 1101.0101\ 1001)_2$

~~21656~~
21675.262

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Binary Codes
- Weighted
- Non-weighted (Excess-3, Gray code)
- Sequential (Gray Code)
- Alpha-numeric (ASCII)
- Error-correcting & detecting (Parity)
- Reflective

Non-weighted

Excess-3.

$(123)_{10} \rightarrow$

	0001	0010	0011
+	0011	0011	0011
	0100	0101	0110

2	123	
2	61	1
2	30	1
2	15	0
2	7	1
2	3	1
	1	1

Gray Codes

These are also called cyclic codes

Q Convert $(101011)_G \rightarrow (\ )_2$

1 0 1 0 1 1

$\oplus\ \oplus\ \oplus\ \oplus\ \oplus$

$(1\ 1\ 0\ 0\ 1\ 0)_2$

Steps $(\ )_G \rightarrow (\ )_2$

1) Diagnoll EXOR of the bits.

$(\ )_2 \rightarrow (\ )_G$

EXOR adjacent bits

~~(1010~~ $(11\ 0\ 0\ 1\ 0)_2$

$(1\ 0\ 1\ 0\ 1\ 0\ 1)_G$

Q $(0001010111)_G \rightarrow (\ )_2$

$(0001100101)_2$

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$(11000\ 1010101011)_2 \rightarrow (\ )_G$

$(10100111111110)_G$

BCD (Binary Coded decimal)

	Binary	BCD
0	✓	✓
9	✓	✓
10	1010	0001 0000

Q Give Binary, BCD, excess-3 & grey code of the follo.
→ 1) 5
2) 8
3) 14

$(5)_{10} \rightarrow (0101)_2 \rightarrow (0101)_{BCD} \rightarrow (1000)_{Excess 3}$
$\hookrightarrow (0110)_G$

  0101
+0011
  1000

	Binary	BCD	Excess - 3	Grey code
8	1000 (8 4 2 1)	1000	1011	~~1101~~ 1100
14	1110	00010100	01000111	1001

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Rules in BCD addition

I. If sum is equal to or less than 9 and carry is 0 then it is valid BCD

II. If sum is greater than 9 with carry == 0 we add 6 (0110) to make it valid.

III. If sum <= 9 with carry = 1, we add 6 to make it valid BCD.

Q.

$$\begin{array}{r} 9 \\ +8 \end{array} \qquad \begin{array}{r} 1001 \\ 1000 \\ \hline 0001\ 0001 \\ +\ 0110 \\ \hline 0001\ 0111 \end{array}$$

0001 0001 → invalid

0001 0111 → 17

Q. Add $(57)_{10}$ & $(26)_{10}$

$$\begin{array}{r} 57 \\ +26 \end{array} \qquad \begin{array}{r} 0101\ 0111 \\ 0010\ 0110 \\ \hline \underbrace{0111}\ \underbrace{1101} \\ +0110 \\ \hline 1000\ 0011 \end{array}$$

Q. Add $(569)_{10}$ & $(687)_{10}$ in BCD

$$\begin{array}{r} 569 \\ 687 \\ \hline 1256 \end{array} \qquad \begin{array}{r} 0101\ 0110\ 1001 \\ 0110\ 1000\ 0111 \\ \hline 1011\ 1111\ 0000 \end{array}$$

Boolean Algebra → Subtraction, division

Add^n → + → A+B
Multiplication → × → A.B

→ 1+1 = 0 with 1 carry

Truth Table

AND

A	B	AB
1	1	1
1	0	0
0	1	0
0	0	0

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

NOT ⇒ 0 → 1 ($\bar{A}$, A')
1 → 0

A	$\bar{A}$
1	0
0	1

(1) Commutative
A.B = B.A
A+B = B+A

(2) Associative law
A.(B.C) = (A.B).C
A+(B+C) = (A+B)+C

3) Distributive
A.(B+C) = A.B + AC
A + (B.C) = (A+B).(A+C)

4) De Morgan's
$\overline{A.B} = \bar{A} + \bar{B}$
$\overline{A+B} = \bar{A}.\bar{B}$

A	B	A.B	$\overline{A.B}$	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$
1	1	1	0	0	0	0
1	0	0	1	0	1	1
0	1	0	1	1	0	1
0	0	0	1	1	1	1

Duality Principle

$1 \rightarrow 0$

$0 \rightarrow 1$

$\cdot \rightarrow +$

$+ \rightarrow \cdot$

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

$\rightarrow A \cdot (B + C) \cdot D$

AND laws

$A \cdot 0 = 0$

$A \cdot 1 = A$

$A \cdot A = A$

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

OR Laws

$A + 0 = A$

$A + 1 = 1$

$A + A = A$

$A + \bar{A} = 1$

A	$\bar{A}$	$A \cdot \bar{A}$
1	0	0
0	1	0

A	$\bar{A}$	$A + \bar{A}$
1	0	1
0	1	1

Inversion Laws

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

Q (1) $A + \bar{A} \cdot B = (A + \bar{A}) \cdot (A + B) = 1 \cdot (A + B)$

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

Q ~~Simplify y~~ = Prove $((A + \bar{B}) + AB)(A + \bar{B})(\bar{A}B) = 0$

$((A + \bar{B}) + AB)(A + \bar{B})(\bar{A}B) = 0$

$(A + (\bar{B} + AB)) \cdot (A + \bar{B})(\bar{A}B) = 0$ Acc to associative

$\cancel{(\quad)(\quad)(A + \bar{B}) = 0}$

$(A + (\bar{B} + AB))(A\bar{A}B + \bar{B}\bar{A}B) = 0$

$(A + (\bar{B} + AB))(0 \cdot B + 0 \cdot \bar{A}) = 0$

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Q Simplify $y = (AB + C).(AB + D)$

$y = AB(AB + D) + C(AB + D)$

$= AB\,AB + ABD + CAB + CD$

$= AB(1 + D + C) + CD$

$= AB + CD$

Q Simplify $A.\bar{B}.C + \bar{A}.B.C + ABC$

$\Rightarrow C(A.\bar{B}.1 + \bar{A}.B + AB)$

$\Rightarrow C(A(\bar{B} + B) + \bar{A}B)$

$\Rightarrow C(A.1 + \bar{A}B)$

$\Rightarrow C(A + (\bar{A}B)) \Rightarrow C((A + \bar{A}).(A + B))$

$\Rightarrow \cancel{C(0 + A.B)}$

$C(A + B)$

$= AB + BC$

Q Simplify $y = \overline{(\bar{A}B + \bar{A} + AB)} = \overline{\bar{A}B}.\bar{\bar{A}}.\overline{AB}$

$= AB.A.\overline{AB}$

$= \cancel{(AB + A + \overline{AB})} = (A.B.\bar{A}) + \bar{B}.A.\bar{B}$

$\Rightarrow \cancel{A(B + 1) + \overline{AB}} = 0.B + 0.A$

$\Rightarrow \cancel{AB + A}\ \ \cancel{A + \overline{AB}} = 0$

$\Rightarrow \cancel{(A + \bar{A}).(A + \bar{B})}$

Q Simplify $y = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$

$= \bar{C}(\bar{A}\bar{B} + \bar{A}B + A\bar{B} + AB)$

$= \bar{C}(\bar{A}(\bar{B} + B) + A(\bar{B} + B))$ As $\bar{B} + B = 1$

$= \bar{C}(\bar{A} + A)$ As $\bar{A} + A = 1$

$= \bar{C}$

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Q Simplify $y = ABC + A\bar{B}C + AB\bar{C}$

$= A(BC + \bar{B}C + B\bar{C})$

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

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

$= A((C+B).(C+\bar{C}))$ $\quad \{ C+(B.\bar{C}) = (C+B).(C+\bar{C})$

$= A(B+C)$

Q Simplify $y = \bar{A}C(\overline{\bar{A}BD}) + \bar{A}B\bar{C}\bar{D} + A\bar{B}C$

$= \bar{A}.C(\bar{\bar{A}}+\bar{B}+\bar{D}) + \bar{A}B\bar{C}\bar{D} + A\bar{B}C$

$= \cancel{\bar{A}.C(A+\bar{B}+D) + \bar{A}B\bar{C}\bar{D}} + A\bar{B}C$

$= \cancel{\bar{A}.C.A + \bar{A}CB + \bar{A}CD + \bar{A}B\bar{C}\bar{D}} + A\bar{B}C$

$= \cancel{\bar{A}(CB + CD + B\bar{C}\bar{D}) + A\bar{B}C}$

$\Rightarrow \cancel{\bar{A}(CB + D(C+(B\bar{C}))) + A\bar{B}C}$

$\Rightarrow \cancel{\bar{A}(CB + D((C+B).(C+\bar{C}))) + A\bar{B}C}$

$\Rightarrow \cancel{\bar{A}(CB + DC + DB) + \cancel{AB}\ A\bar{B}C}$

$\Rightarrow \bar{A}.C(A+\bar{B}+\bar{D}) + \bar{A}B\bar{C}\bar{D} + A\bar{B}C$

$\Rightarrow \bar{A}C(\bar{B}+\bar{D}) + \bar{A}B\bar{C}\bar{D} + A\bar{B}C$

$\Rightarrow \bar{A}\bar{B}C + \bar{A}\bar{D}C + \bar{A}B\bar{C}\bar{D} + A\bar{B}C$

$\Rightarrow \bar{B}C(\bar{A}+A) + \bar{A}\bar{D}[C + (B\bar{C})]$

$\Rightarrow \bar{B}C + \bar{A}\bar{D}[(C+B).(C+\bar{C})]$

$\Rightarrow \bar{B}C + \bar{A}\bar{D}(C+B)$

Q If $A\bar{B} + \bar{A}B\cancel{R} = C$ Show, $A\bar{C} + \bar{A}C = B$

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

$= (\overline{A\bar{B}}).(\overline{\bar{A}B})$

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

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

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

$\Rightarrow \overset{0}{\cancel{A\bar{A}\bar{B}}} + AAB + \overset{0}{\cancel{\bar{A}A\bar{B}}} + \bar{A}\bar{A}B$

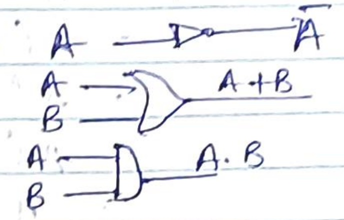
$\Rightarrow AB + \bar{A}B = B$

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

$\Rightarrow B = B$

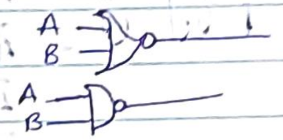
LOGIC GATES

Basic gates:
- NOT →
- OR (+) →
- AND (·) →

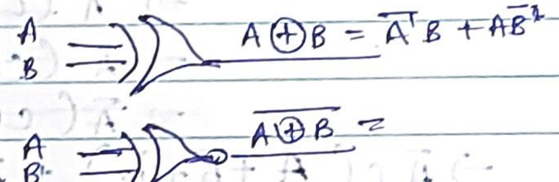


A	B	C
1	1	1
1	1	0
1	0	1
1	0	0
0	1	1
0	1	0
0	0	1
0	0	0

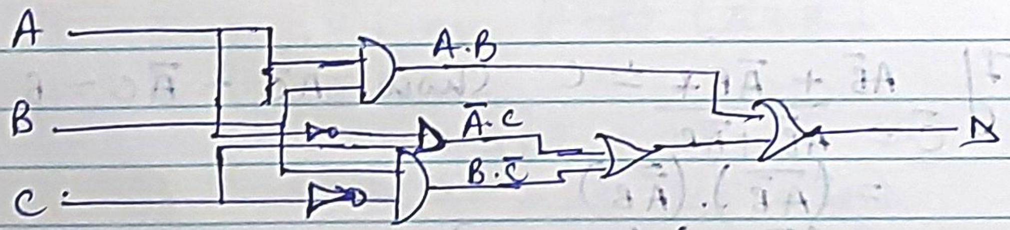
Universal:
- NOR →
- NAND

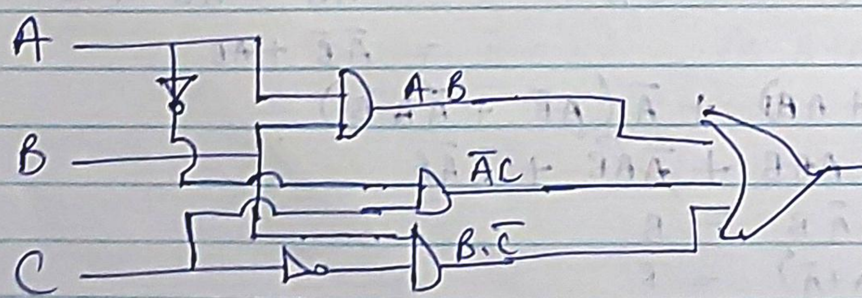


Exclusive Gates
- XOR
- XNOR



Q Draw logic diagram for the given equation
$AB + \bar{A}C + B\bar{C}$





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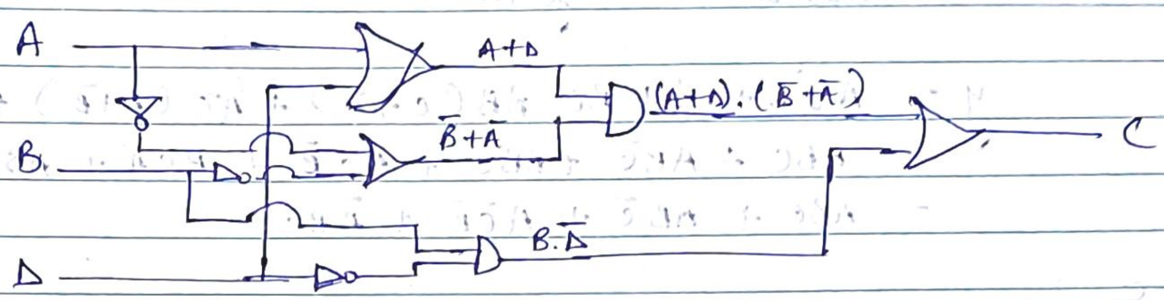
(ii) $(A+D)(\bar{B}+\bar{A}) + B.\bar{D}$



SOP and POS

SOP → $AB + BD + \bar{B}C$

POS → $(A+B).(B+D).(\bar{A}+C)$

In case of min terms or SOP we compliment the variable where zero exists

DIGITS	BINARY	SOP (min terms)	POS (maxterm)
0	000	$\bar{A}\bar{B}\bar{C}$	$A+B+C$
1	001	$\bar{A}\bar{B}C$	$A+B+\bar{C}$
2	010	$\bar{A}B\bar{C}$	$A+\bar{B}+C$
3	011	$\bar{A}BC$	$A+\bar{B}+\bar{C}$
4	100	$A\bar{B}\bar{C}$	$\bar{A}+B+C$
5	101	$A\bar{B}C$	$\bar{A}+B+\bar{C}$
6	110	$AB\bar{C}$	$\bar{A}+\bar{B}+C$
7	111	ABC	$\bar{A}+\bar{B}+\bar{C}$

010 011 101

Minterms → $\Sigma m(2,3,5) \rightarrow \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}C$

Maxterms (POS) → $\Pi M(2,3,5) \rightarrow (A+\bar{B}+C).(A+\bar{B}+\bar{C})+(\bar{A}+B+\bar{C})$

Q. Convert the expression $y = AB + A\bar{C} + B.C$ into standard SOP form

$y = \cancel{A[B+\bar{C}]} + \cancel{BC}\ AB(C+\bar{C}) + A\bar{C}(B+\bar{B}) + BC(\bar{A}+A)$

$= ABC + AB\bar{C} + AB\bar{C} + A\bar{C}\bar{B} + BC\bar{A} + ABC$

$= ABC + AB\bar{C} + A\bar{C}\bar{B} + \bar{A}BC$

Q. Convert $y = A + B.C + ABC$ into SOP

$= A(B+\bar{B}) + B.C(A+\bar{A}) + ABC$

$= AB + A\bar{B} + BCA + \bar{A}BC + ABC$

$= ABC + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + ABC + \bar{A}BC + ABC$

$= ABC + AB\bar{C} + A\bar{B}C + A\bar{B}\bar{C} + \bar{A}BC$

Q. Convert $y = (A+B)(A+C)(B+\bar{C})$ into std POS.

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

ERROR DETECTING & CORRECTING

Parity Bits → Even, → Odd

Bits	Binary	Even Parity	Odd Parity
0	000	0	1
1	001	1	0
2	010		
3	~~1000~~ 011		
4	100		
5	101		
6	110		
7	111		

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Q. If we have transmitted data 0110 then find no. of parity bits with even parity.

Ans 0110 → $n = 4$ ↳ even

$\therefore 2^k \geq n + k + 1$ → parity

$\Rightarrow 2^k \geq 4 + k + 1$

$\Rightarrow k = 3$

Error posn	P_3 C_1	P_2 C_2	P_1 → Parity C_3 → Correct
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

	2^2			2^1		2^0
D_7	D_6	D_5	D_4	D_3	D_2	D_1
0	1	1	P_3	0	P_2	P_1
0	1	1	0	0	1	1

$P_1 = 1, 3, 5, 7$

P_1 0, 0, 1 → $P_1 = 1$

$P_2 = 2, 3, 6, 7$ → $P_2 = 1$

P_2, 0, 0, 1, 0

$P_3 = 4, 5, 6, 7$ → $P_3 = 0$

P_3, 1, 1, 0

Q. At receiver end, the receiver codeword is 0110111. Find the bit which errorious with even parity

$C_1 = 4\ 5\ 6\ 7$ $C_1 = 0$

0 1 1 0

$C_2 = 2\ 3\ 6\ 7$ $C_2 = 1$

1 1 1 0

$C_3 = 1\ 3\ 5\ 7$ $C_3 = 1$

1 1 1 0

$C_1\ C_2\ C_3$

0 1 1

Unitz-2

Minimization of switching func^n s.

~~Karnaugh Map (K-Map)~~

Methods to simplify Boolean expression:

→ Algebraic Expression
→ K-Map
→ Q-Map

(SOP) Karnaugh Map (K-Map)

① 2 variables → A & B

B \ A	$\bar{A}$ 0	A 1
$\bar{B}$ 0	0	1
B 1	2	3

② 3 variables ($2^3 = 8$ cell)

A \ BC	$\bar{B}\bar{C}$ 00	$\bar{B}C$ 01	BC 11	$B\bar{C}$ 10
$\bar{A}$ 0	0	1	3	2
A 1	4	5	7	6

③ 4-variable ($2^4 = 16$ cells)

0	1	3	2
4	5	7	6
12	13	15	14
8	9	11	10

Pair : A group of 2 adjacent & 1s & 0s

Quad : A grp of 4 adjacent 1s & 0s

Octate : Grp 8 adjacent 1s & 0s.

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Q $y = \Sigma m(1, 3, 2, 7)$

↳ SOP ↳ 0–7 ⇒ 2^3 ⇒ A, B, C

$\bar{A}$ \ A	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	1 1	1 3	1 2
A	4	5	1 7	6

→ ②

①

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

Q $y = \cancel{mto}\ \Sigma m (m_0\ m_1\ m_2\ m_5\ m_{13}\ m_{15})$
get simplified expression.

$\Rightarrow y = (0, 1, 2, 5, 13, 15)$

CD \ AB	$\bar{A}\bar{B}$	$A\bar{B}$	AB	$\bar{A}B$
$\bar{C}\bar{D}$	1 0	1 1	3	1 2
$C\bar{D}$	4	1 5	7	6
CD	12	1 13	1 15	14
$\bar{C}D$	8	9	11	10

$\bar{A}\bar{B}\bar{C}\bar{D}$

Q Minimize the following: $y = \Sigma m(1, 2, 9, 10, 11, 14, 15)$
& draw logic circuit for the realized

CD \ AB	$\bar{A}\bar{B}$	$A\bar{B}$	AB	$\bar{A}B$
$\bar{C}\bar{D}$	0	1 1	3	1 2
$\bar{C}D$	4	5	7	6
CD	12	12	1 15	1 14
$\bar{C}D$	8	1 9	1 11	1 10

~~$A\bar{B}\bar{C} + \bar{A}B\bar{D}$~~

$y = BD + A\bar{B}\bar{C} + \bar{A}B\bar{C}$

$= \cancel{B(A+} BD + \bar{C}(A\bar{B} + \bar{A}B)$

$= BD + \bar{C}(A \oplus B)$

A

B

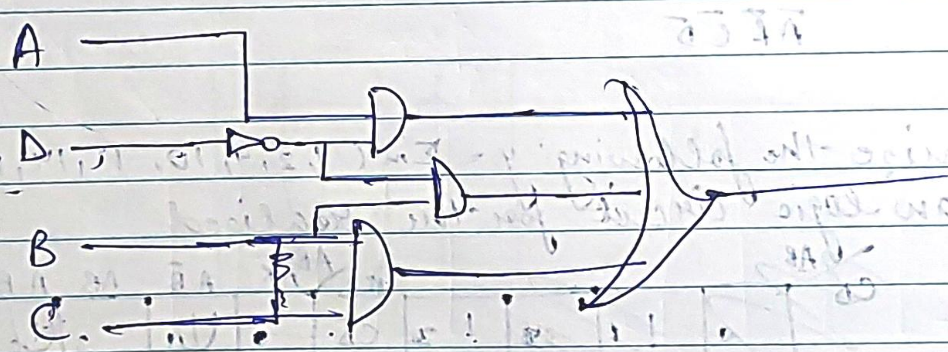
C

D

Q $y = (m_4 + m_5 + m_8 + m_9 + m_{11} + m_{12} + m_{13} + m_{15})$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	3	2
$\bar{A}B$	1 4	1 5	7	6
AB	1 12	1 13	1 15	14
$A\bar{B}$	1 8	1 9	1 11	10

$y = B\bar{D} + CB + A\bar{D}$



K-Map (POS)

2 variable

A \ B	B	$\bar{B}$
A	(A+B) 0	$(A+\bar{B})$ 1
$\bar{A}$	$(B+\bar{A})$ 2	$(\bar{A}+\bar{B})$ 3

3-variable:

A \ BC	B+C	B+$\bar{C}$	$\bar{B}$+$\bar{C}$	$\bar{B}$+C
A	1 (0)	0 (1)	0 (3)	1 (2)
$\bar{A}$	0 (4)	1 (5)	1 (7)	1 (6)

Q $y = \pi M(0, 4, 5, 7, 10, 11, 14, 15)$

AB \ CD	C+D	C+$\bar{D}$	$\bar{C}$+$\bar{D}$	$\bar{C}$+D
A+B	0 (0)	(1)	(3)	(12)
A+$\bar{B}$	0 (4)	0 (5)	0 (7)	(6)
$\bar{A}$+$\bar{B}$	(12)	(13)	0 (15)	0 (14)
$\bar{A}$+B	(8)	(9)	0 (11)	0 (10)

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

K-Map with don't care condⁿ (X or d)

In case of K-map it is not always true that the cells containing ones (SOP) will contain zeroes becuz some combinations of input variables don't occur. In such situations we have freedom to assume to have a zero or one as output for each of these combinations. These conditions are called don't care condⁿs.

Q. Minimise the expansion $y = \Sigma M(0,1,5,9,13,14,15) + d(3,4,7,10,11)$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1 (0)	1 (1)	d (3)	2
$\bar{A}B$	d (4)	1 (5)	d (7)	6
AB	12	1 (13)	1 (15)	1 (14)
$A\bar{B}$	8	1 (9)	d (11)	d (10)

$y = D + AC + \bar{A}\bar{C}$

Q. Simplify $y = (m_1, m_4, m_8, m_{12}, m_{13}, m_{15}) + d(3,14)$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1 (1)	d (3)	2
$\bar{A}B$	1 (4)	5	7	6
AB	1 (12)	1 (13)	1 (15)	d (14)
$A\bar{B}$	1 (8)	9	11	10

$y = B\bar{C}\bar{D} + AB\cancel{B} + \bar{A}\bar{B}D + \bar{A}\bar{C}\bar{D}$

5 variable K-map ⇒ 32 cells

A = 0

BC \ DE	$\bar{D}\bar{E}$	$\bar{D}E$	DE	$D\bar{E}$
$\bar{B}\bar{C}$	1 (0)	1	3	2
$\bar{B}C$	4	1 (5)	1 (7)	6
BC	12	13	15	14
$B\bar{C}$	8	9	11	10

A = 1

BC \ DE				
$\bar{B}\bar{C}$	16	17	19	18
$\bar{B}C$	20	21	23	22
BC	29	30	31	32
$B\bar{C}$	24	25	28	27

Q. Simplify $y(ABCDE) = \Sigma m(0, 2, 5, 7, 13, 15, 18, 20, 21, 23, 28, 29, 31)$

$\bar{A}$

BC \ DE	$\bar{D}\bar{E}$	$\bar{D}E$	DE	$D\bar{E}$
$\bar{B}\bar{C}$	1 (0)	1	3	1 (2)
$\bar{B}C$	4	1 (5)	1 (7)	6
BC	12	1 (13)	1 (15)	14
$B\bar{C}$	8	9	11	10

A

BC \ DE	$\bar{D}\bar{E}$	$\bar{D}E$	DE	$D\bar{E}$
$\bar{B}\bar{C}$	16	17	19	1 (18)
$\bar{B}C$	1 (20)	1 (21)	1 (23)	22
BC	1 (28)	1 (29)	1 (31)	30
$B\bar{C}$	24	25	27	26

$y = CE + \bar{B}\bar{C}D\bar{E} + \bar{A}\bar{B}\bar{C}\bar{E} + ACD$

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Q $f(ABCDE) = \Sigma(0, 1, 7, 9, 11, 13, 15, 16, 17, 23, 25, 27)$

0	1	3	2
4	5	7	6
12	13	15	14
8	9	11	10

16	17	19	18
20			