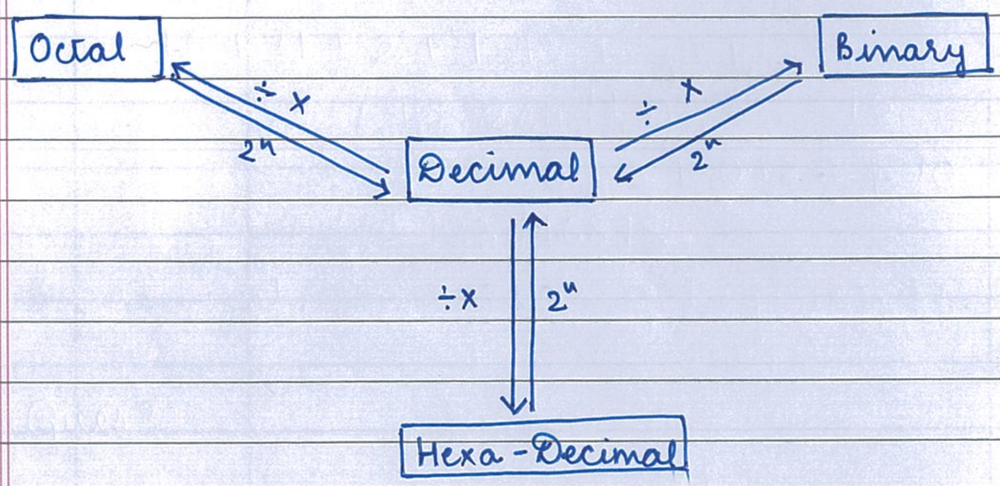


Unit - I
Number Systems

1) Binary Number System
2) Octal Number System (0, 1, 2 - - - , 7)
3) Decimal Number System (0, 1, 2 - - - , 9)
4) Hexadecimal Number system (0, 1, 2 - - - -, 9, A, B - - -, F)

Ques-1

$(23.47)_{10} = (\quad)_2$

2	23	→ 1
2	11	→ 1
2	5	→ 1
2	2	→ 0
	1	

$(23)_{10} \rightarrow (10111)_2$

0.47×2	=	0.94	0
0.94×2	=	1.88	1
0.88×2	=	1.76	1
0.76×2	=	1.52	1
0.52×2	=	1.04	1
0.04×2	=	0.08	0

$(0.47)_{10} \rightarrow (.011110)_2$

$= (10111.011110)_2$

Ques-2

$(10111.011110)_2 = (\quad)_{10}$

$= 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0 +$
$0\times2^{-1} + 1\times2^{-2} + 1\times2^{-3} + 1\times2^{-4} +$
$1\times2^{-5} + 0\times2^{-6}$

$= 16+4+2+1+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\frac{1}{32}$

$= 23 + 0.25 + 0.125 + 0.0625 + 0.03125$

$= 23.46875$

Ques 3

$(23.178)_{10} \rightarrow (\quad)_8$

8	23 → 7	
8	2 → 2	$= (27)_8$
	0	

$0.178 \times 8 = 1.424$ 1

~~$0.356 \times 8 = 2.848$ 2~~

~~$0.848 \times 8 =$~~

$0.424 \times 8 = 3.392$ 3

$0.392 \times 8 = 3.136$ 3

$0.136 \times 8 = 1.088$ 1

$= (0.1331)_8$

$= (27.1331)_8$

Ques-4

$(27.1331)_8 = (\,)_{10}$

$8^1\times2 + 8^0\times7 + 8^{-1}\times1 + 8^{-2}\times3 + 8^{-3}\times3 +$
$8^{-4}\times1$

$= 16+7+\frac{1}{8}+\frac{3}{64}+\frac{3}{8}+\frac{1}{32}$ ~~$+ 0.03125$~~

$= 23 + 0.125 + 0.046875 + 0.005514 +$
0.000229

$= (23.0177618)_{10}$

Ques-5

$(92.27)_{10} = (\quad)_{16}$

16	92 → 12 → C	
16	5 → 5	
	0	

$= (5C)_{16}$

$0.27 \times 16 = 4.32$ 4

$0.32 \times 16 = 5.12$ 5

$0.12 \times 16 = 1.92$ 1

$0.92 \times 16 = 14.72$ 14 → E

$(0.27)_{10} = (0.451E)_{16}$

$= (5C.451E)_{16}$

Ques - 6

$(5C \cdot 451E)_{16} \rightarrow (\quad)_{10}$

$5 \times 16^{1} + C \times 16^{0} + 4 \times 16^{-1} + 5 \times 16^{-2} + 1 \times 16^{-3} + E \times 16^{-4}$

$= 80 + 12 + \frac{4}{16} + \frac{5}{256} + \frac{1}{4096} + \frac{14}{65536}$

$92 + 0.25 + 0.01953 + 0.000244 + 0.000213$

$= (92.269987)_{10}$

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

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

Ques - 7

$(23.47)_8 = (\quad)_2$

$= (010011 \cdot 100111)_2$

Ques - 8

$(01011101 \cdot 11001011)_2 = (\quad)_8$

$= (135 \cdot 626)_8$

Ques - 9

$(4AE \cdot D7F)_{16} = (\quad)_2$

$(010010101110 \cdot 110101111111)_2$

Ques - 10

$(\underbrace{10}\underbrace{101}\underbrace{110}\underbrace{111} \cdot \underbrace{1101}\underbrace{0110}\underbrace{11})_2 = (\quad)_{16}$

$= (5\ 7\ 7 \cdot D6C)_{16}$

Codes

Decimal	Binary	BCD Code (Binary Coded Decimal Code) 8 4 2 1	5 4 2 1
0	0000	0000	0000
1	0001	0001	0001
2	0010	0010	0010
3	0011	0011	0011
4	0100	0100	0100
5	0101	0101	1000
6	0110	0110	1001
7	0111	0111	1010
8	1000	1000	1011
9	1001	1001	1100
10	1010	N.E	N.E
11	1011	N.E (Not Exist)	N.E
12	1100	N.E	N.E
13	1101	N.E	N.E
14	1110	N.E	N.E
15	1111	N.E	N.E

Ques - 11

1) $(7)_{10}$

$= (0111)_{BCD}$

$= (111)_2$

2) $(19)_{10} = (10011)_2 = (00011001)_{BCD}$

Excess-3 Code

Digit	BCD	Excess-3 Code	
0	0000	0011	→ 3
1	0001	0100	→ 4
2	0010	0101	→ 5
3	0011	0110	→ 6
4	0100	0111	→ 7
5	0101	1000	→ 8
6	0110	1001	→ 9
7	0111	1010	→ 10 → A
8	1000	1011	→ 11 → B
9	1001	1100	→ 12 → C

Gray Code

① $(27)_{10} = (\quad)_2 = (\quad)$ graycode

2	27 → 1
2	13 → 1
2	6 → 0
2	3 → 1
	1

$(27)_{10} = (11011)_2$

~~10010~~

| 0 + 0 = 0
| 0 + 1 = 1
| 1 + 1 = 0

$(11011)_2 \rightarrow (\quad)$ gray code

$= (10110)$ graycode

11011

10110

(11011)₂

② $(38)_{10}$

2	38 → 0
2	19 → 1
2	9 → 1
2	4 → 0
2	2 → 0
	1

$= (100110)_2$

$(100110)_2$

$= (110101)$ gray code

$(100110)_2$

BCD Addition

$(23)_{10\,BCD} = 00100011$

$+ (47)_{10\,BCD} = 01000111$

01101010

6 A

Add 6

01101010

+ 00000110

01110000

7 0

$(43)_{BCD}$ = 01000011
$(72)_{BCD}$ = 01110010

10110101

B 5

10110101
+ 00000110 (Add 6)

10111011

10110101
00100000

000100010101

$(1\ 1\ 5)_{BCD}$

Ques.

$(49)_{BCD}$ = 01001001
$(38)_{BCD}$ = 00111000

$(87)_{BCD}$ 10000001
+ 00000111

8 1

10000111 → $(87)_{BCD}$

i) Add 6 in lower nibble
if
@ its value greater than 9
ⓑ addition of D_3 bit carry is generated

ii) Add 6 in upper nibble
@ its value greater than 9
ⓑ addition of D_7 bit carry bit carry is generated

Ques

$(94)_{BCD}$ = 1001 0100
$(83)_{BCD}$ = 1000 0011

$(177)_{BCD}$ ① 0001 0111
0110 0000

0001 0111 0111
1 7 7

1) Binary Addition

$(27)_{10} = (11011)_2$ = 00011011
$(38)_{10} = (100110)_2$ = 00100110

$(01000001)_2$

00011011
00100110

$(01000001)_2$

||

$(65)_{10}$

2) Octal Addition

i) $(76)_8 + (43)_8 = (\ \ \ )_8$

$(76)_8 = (111110)_2$ = 10011010
$(43)_8 = (100011)_2$ 10101

$(141)_8$

ii) $(47)_8$
$(56)_8$

$(125)_8$

00
01
02
03
04
05
06
07
10
11
12
13
14
15
16
17
20

3) Hexadecimal Addition

i) $(1AB)_{16} + (A24)_{16}$

```
  1 A B
  A 2 4
 ------
 (B C F)16
```

00	10
01	11
02	12
03	13
04	14
05	15
06	16
07	17
08	18
09	19
0A	1A
0B	1B
0C	1C
0D	1D
0E	1E
0F	1F

ii) $(AFD)_{16}$
$(B9A)_{16}$

```
    1 1
    A F D
    B 9 A
 ---------
 (1 6 9 7)16
```

Subtraction

① Subtraction using 1's compliment
$(38)_{10} - (27)_{10}$
$(100110)_2 - (11011)_2$

```
0 0 1 0 0 1 1 0
0 0 0 1 1 0 1 1
```

38 + (−27)

$(-27)_{10}$ = 000 11011
1's compl. = 11100100

```
 1 1    1
 0 0 1 0 0 1 1 0
 1 1 1 0 0 1 0 0
-----------------
(1) 0 0 0 0 1 0 1 0
                  1
```

discard carry — Add carry here

$(00001011)_2 = (11)_{16}$

② $(27)_{10} - (38)_{10}$

$27 = (00011011)_2$
$38 = (00100110)_2$

$(-38)_{10} = (11011001)_2$

```
      27 =  0 0 0 1 1 0 1 1
     -38 =  1 1 0 1 1 0 0 1
 +         (1 1 1 1 0 1 0 0)2
```

(00001011) 1's cop $= (-11)_{10}$

When carry does not come, take 1's compliment of answer

Subtraction using 2's compliment

a) $(38)_{10} - (27)_{10}$

$(38)_{10} = (100110)_2 = (00100110)_2$

$(27)_{10} = (11011)_2 = (00011011)_2$

$(38)_{10} - (27)_{10} = (38)_{10} + (-27)_{10}$

$(27)_{10} = (00011011)_2$

11100100 → 1's complime

+ 1

11100101 → 2's compliment.

$(38)_{10} = 00100110$

$(-27)_{10} = 11100101$

1 $(00001011)_2 = (11)_{10}$

discard card

$= (11)_{10}$

b) $(27)_{10} - (38)_{10}$

$(27)_{10} = (11011)_2 = (00011011)_2$

$(38)_{10} = (100110)_2 = (00100110)_2$

$(27)_{10} - (38)_{10} = (27)_{10} + (-38)_{10}$

$38_{10} = 00100110$

11011001 → 1's compl

+ 1

11011010 → 2's compl

$(27)_{10} = 00011011$

$(-38)_{10} = 11011010$

$= 11110101$

no carry ∴ no is negative

2's compliment

1's comp → 00001010

+ 1

$00001011 \rightarrow (11)_{10}$

Subtraction using 7's compliment

a) $(47)_8 - (36)_8$

$(47)_8 + (-36)_8$

= 77

- 36

41 → 7's complim

47

+ 41

110

carry

$= (10)_8$

+ 1

$(11)_8$

b) $(36)_8 - (47)_8 = (36)_8 + (-47)_8$

$$\begin{array}{r} 77 \\ -47 \\ \hline 30 \end{array} \rightarrow \text{7 comp}$$

$$\begin{array}{r} 36 \\ +30 \\ \hline 66 \end{array}$$

$$\begin{array}{r} 77 \\ -66 \\ \hline 11 \end{array} \rightarrow \text{7 comp.} = (-11)_8$$

Subtraction using 8's compliment

a) $(47)_8 - (36)_8 = (47)_8 + (-36)_8$

$$\begin{array}{r} 77 \\ -36 \\ \hline 41 \\ +1 \\ \hline 42 \end{array} \quad \begin{array}{l} \\ \\ \rightarrow \text{7's compu} \\ \\ \\ \rightarrow \text{8's compu} \end{array}$$

$$\begin{array}{r} 47 \\ +42 \\ \hline 111 \end{array} = (11)_8$$

discard carry the

ⓑ $(36)_8 - (47)_8$

$= (36)_8 + (-47)_8$

$$\begin{array}{r} 77 \\ -47 \\ \hline 30 \\ +1 \\ \hline 31 \end{array} \quad \begin{array}{l} \\ \\ - \text{7 comp} \\ \\ \\ \rightarrow \text{8' comp.} \end{array}$$

$$\begin{array}{r} 36 \\ 31 \\ \hline 67 \end{array}$$

$$\begin{array}{r} 77 \\ -67 \\ \hline 10 \\ +1 \\ \hline 11 \end{array} \quad \begin{array}{l} \\ \\ \rightarrow \text{7's com} \\ \\ \rightarrow \text{8 co} \end{array}$$

$= (-11)_8$.

Subtraction using 9's ~~cop~~ compliment

ⓐ $(88)_{10} - (47)_{10}$

$(88)_{10} + (-47)_{10}$

$$= \begin{array}{r} 99 \\ -47 \\ \hline (52)_{10} \end{array} \rightarrow \text{9's compe}$$

$$\begin{array}{r} 88 \\ 52 \\ \hline 140 \\ +1 \\ \hline (41)_{10} \end{array} = (41)_{10}$$

carry

b) $(47)_{10} - (88)_{10}$
$(47)_{10} + (-88)_{10}$

$$\begin{array}{r} 99 \\ -88 \\ \hline 11 \end{array} \rightarrow \text{9's comp.}$$

$$\begin{array}{r} 47 \\ +11 \\ \hline 58 \end{array}$$

$$\begin{array}{r} 99 \\ -58 \\ \hline 41 \end{array} = (-41)_{10}.$$

Subtraction using 10's comp.

a) $(88)_{10} - (47)_{10} = (88)_{10} + (-47)_{10}$

$$\begin{array}{r} 99 \\ -47 \\ \hline 52 \end{array} \rightarrow \text{9's comp.}$$
$$\begin{array}{r} +1 \\ \hline 53 \end{array} \rightarrow \text{10's co.}$$

$$\begin{array}{r} 88 \\ 53 \\ \hline 1\,41 \end{array} = (41)_{10}.$$

carry

b) $(47)_{10} - (88)_{10} = (47)_{10} + (-88)_{10}$

$$\begin{array}{r} 99 \\ -88 \\ \hline 11 \end{array} \rightarrow \text{9's comp}$$
$$\begin{array}{r} +1 \\ \hline 12 \end{array} \rightarrow \text{10's comp}$$

$$\begin{array}{r} 47 \\ +12 \\ \hline 59 \end{array}$$

$$\begin{array}{r} 99 \\ -59 \\ \hline 40 \end{array} \rightarrow \text{9's com}$$
$$\begin{array}{r} +1 \\ \hline 41 \end{array} - \text{10's com}$$

$= (-41)_{10}$

Subtraction using 15's and 16's complement

1) $(A2B6)_{16} - (2476)_{16}$

$(A2B6)_{16} + (-2476)_{16}$ using 15's compl.

```
  F F F F
- 2 4 7 6
(D B 8 9)15's comp

  A 2 B 6
+ D B 8 9
① 7 E 3 F
```

$= (7E3F)_{16}$
$+ \quad 1$
$(7E40)_{16}$

00	10
01	11
02	12
03	13
04	14
05	15
06	16
07	17
08	18
09	19
0A	1A
0B	1B
0C	1C
0D	1D
0E	1E
0F	1F

2) $(2476)_{16} - (A2B6)_{16}$

$(2476)_{16} + (-A2B6)_{16}$

```
  F F F F
- A 2 B 6
  5 D 4 9

  2 4 7 6          F F F F
  5 D 4 9   →    - 8 1 B F
  8 1 B F          7 E 4 0
```

No carry = $(-7E40)_{16}$

Q2. a) $(A2B6)_{16} - (2476)_{16}$ using 16's compliment

$(A2B6)_{16} + (-2476)_{16}$

```
  F F F F
- 2 4 7 6
  D B 8 9  —— 15's comp.
+       1
  D B 8 A  —— 16's comp

  A 2 B 6
+ D B 8 A
① 7 E 4 0
```

Discard

Ans - $(7E40)_{16}$

b) $(2476)_{16} - (A2B6)_{16}$

$(2476)_{16} + (-A2B6)_{16}$

```
  F F F F
- A 2 B 6
  5 D 4 9  →  15's com
+       1
  5 D 4 A  —  16's comp

  2 4 7 6          F F F F
+ 5 D 4 A   →    - 8 1 C 0
  8 1 C 0          7 E 3 F
                 +       1
                   7 E 4 0   = (-7E40)16
```

Binary Multiplication

$1 \times 0 = 0$
$1 \times 1 = 1$
$0 \times 1 = 0$

1) $(38)_{10} \times (27)_{10}$

$(38)_{10} = (100110)_2$
$(27)_{10} = (11011)_2$

2	38 → 0		2	27 → 1
2	19 → 1		2	13 → 1
2	9 → 1		2	6 → 0
2	4 → 0		2	3 → 1
2	2 → 0			1
	1			

```
       1 0 0 1 1 0
             1 1 1
   -----------------
       1 0 0 1 1 0
     1 0 0 1 1 0 x
   1 0 0 1 1 0 x x
   -----------------
 (1 0 0 0 0 1 0 1 0)2
```

$2^8 + 2^3 + 2^1 = (266)_{10}$

~~Boolean Multiplication~~

Boolean Algebra

1) Commutative Property
a) $x+y = y+x$ + → or logic
b) $x \cdot y = y \cdot x$ · → and logic

OR GATE

x	y	z
0	0	0
0	1	1
1	0	1
1	1	1

AND GATE

x	y	z
0	0	0
0	1	0
1	0	0
1	1	1

2) Associative Property
a) $(x+y)+z = x+(y+z)$
b) $(x \cdot y) \cdot z = x \cdot (y \cdot z)$

3) De Morgan's Theorem
a) $(x+y)' = x' \cdot y'$
b) $(\overline{x+y}) = \bar{x} \cdot \bar{y}$
c) $(x \cdot y)' = x' + y'$
d) $(\overline{x \cdot y}) = \bar{x} + \bar{y}$

Postulates

i) $x + 0 = x$

ii) $x + x' = 1$

iii) $x + x = x$

iv) $x + 1 = \cancel{x}1$

v) ~~$x + x = x$~~ $x \cdot x = x$

vi) $x \cdot x' = 0$

vii) $x \cdot 1 = x$

viii) $x \cdot 0 = 0$

Proof or Minimize the expression using Boolean algebra

1. $x + xy = x$

$x(1+y)\ \cancel{=x}$

$x \cdot 1 = x = R.H.S$

2. $xy + x'z + yz = xy + x'z$

L.H.S

$xy + x'z + yz(x+x')$

$= xy + x'z + xyz + x'yz$

$= xy(1+z) + x'z(1+y)$

$= xy \cdot 1 + x'z \cdot 1$

$= xy + x'z \quad = R.H.S$

3. $xy + \overline{xz} + x\bar{y}z(xy+z) = 1$

L.H.S

$xy + \overline{xz} + x\bar{y}z \cdot xy + x\bar{y}zz$

$= xy + \overline{xz} + x\bar{y}z$

$= x(y + \bar{y}z) + \overline{xz}$

$= x(y+z) + \overline{xz}$

$= xy + xz + \overline{xz}$

$= xy + 1 = 1$ //

4. $(x+y)(\bar{x}\bar{z}+z)(\overline{\bar{y}+xz}) = \bar{x}y$

L.H.S

$(x+y)(\bar{x}\bar{z}+z)(\bar{\bar{y}} \cdot \overline{xz})$

$= (x+y)(\bar{x}\bar{z}+z)(y \cdot \overline{xz})$

$= (x\bar{x}\bar{z} + xz + \bar{x}\bar{z}y + yz)(y \cdot \overline{xz})$

$= (0 + xz + \bar{x}\bar{z}y + yz)(y + \bar{x} + \bar{z})$

$= (y(z + \bar{z}\bar{x}) + xz)(y + (\bar{x} + \bar{z}))$

$(y(z+\bar{x}) + xz)(\bar{x}y + y\bar{z})$

$= (yz + y\bar{x} + xz)(\bar{x}y + y\bar{z})$

$= \bar{x}yyz + yyz\bar{z} + \bar{x}\bar{x}yy + yy\bar{x}\bar{z}$
$+ x\bar{x}yz + xyz\bar{z}$

$= \bar{x}yz + 0 + \bar{x}y + y\bar{x}\bar{z} + 0 + 0$

$= \bar{x}y(1+z) + \bar{x}y\bar{z}$

$= \bar{x}y + \bar{x}y\bar{z}$

$= \bar{x}y(1+\bar{z})$

$= \bar{x}y \cdot 1$

$= \bar{x}y$

5. $A\bar{B}C + B + B\bar{D} + AB\bar{D} + \bar{A}C = B + C$

L.H.S

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

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

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

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

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

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

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

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

6) $(x+y)(y+z)\cdot(x+z) = xy + xz + yz$

$(xy + xz + yy + yz)(x+z)$

$= xxy + xxz + xy + xyz + xyz + xzz + yz$
$+ yz^2$

$= xy + xz + xy + xyz + xyz + xz + yz + yz$

$= xy + xz + yz + xyz$

$= xy + xz + yz(1+x)$

$= xy + xz + yz$

7) If $x\bar{y} + \bar{x}y = z$

Then show that $x\bar{z} + \bar{x}z = y$

Sol: $x\bar{z} + \bar{x}z$

Put the values of z

$= x(\overline{x\bar{y}+\bar{x}y}) + \bar{x}(x\bar{y}+\bar{x}y)$

$= x(\overline{x\bar{y}}\cdot\overline{\bar{x}y}) + \bar{x}x\bar{y} + \bar{x}\bar{x}y$

$= x((\bar{x}+\bar{\bar{y}})\cdot(\bar{\bar{x}}+\bar{y})) + 0 + \bar{x}y$

$= x((\bar{x}+y)\cdot(x+\bar{y})) + \bar{x}y$

$= x(x\bar{x} + \bar{x}\bar{y} + xy + y\bar{y}) + \bar{x}y$

$= x(\bar{x}\bar{y} + xy) + \bar{x}y$

$= x\bar{x}\bar{y} + xxy + \bar{x}y$

$= xy + \bar{x}y$

$= y(x+\bar{x})$

$= y\cdot 1 = y$

Basic Gates

1) NOT GATE

symbol :

$y = \bar{x}$

Truth Table

x	y
0	1
1	0

2) AND GATE

symbol :

$y = a\cdot b$

Truth Table

a	b	y
0	0	0
0	1	0
1	0	0
1	1	1

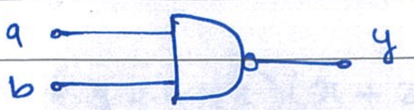
3) OR GATE

symbol :

Truth Table

a	b	y
0	0	0
0	1	1
1	0	1
1	1	1

iv) NAND Gate

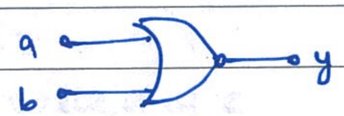
Symbol - 

Truth Table

$y = \overline{a \cdot b}$

a	b	y
0	0	1
0	1	1
1	0	1
1	1	0

v) NOR Gate

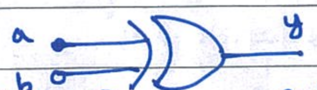
Symbol 

$y = \overline{a+b}$

T.T

a	b	y
0	0	1
0	1	0
1	0	0
1	1	0

vi) XOR Gate

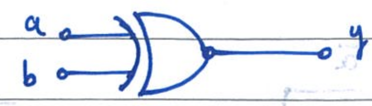
symbol 

$y = \bar{a}b + a\bar{b} = a \oplus b$

T.T

a	b	y
0	0	0
0	1	1
1	0	1
1	1	0

vii) XNOR Gate



$y = \bar{a}\bar{b} + ab = a \odot b$

T.T

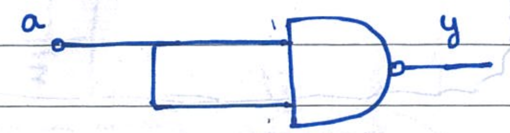
a	b	y
0	0	1
0	1	0
1	0	0
1	1	1

Universal Gates

i) NAND Gates

ii) NOR Gates

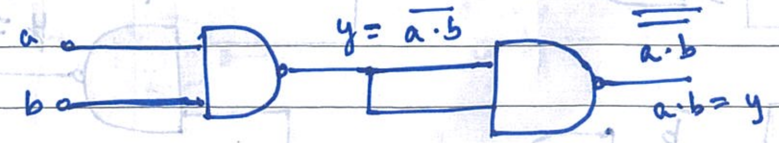
1) Implement NOT Gate using NAND Gate



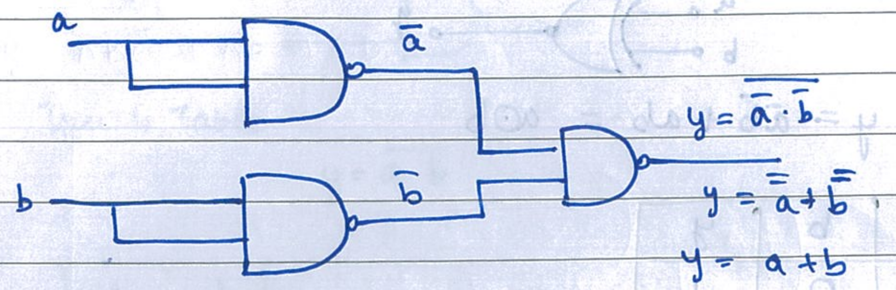
$\overline{a \cdot a} = \bar{a}$

a	y
0	1
1	0

2) Implement AND Gate using NAND Gate

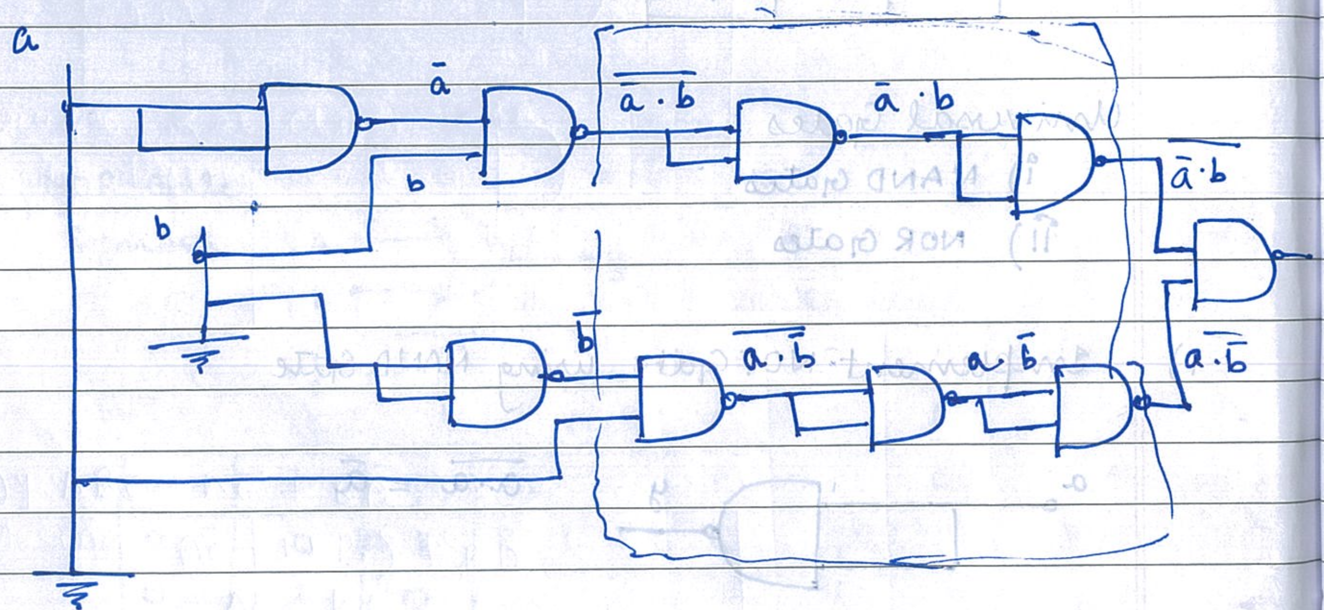


iii) Implement OR Gate using NAND Gate

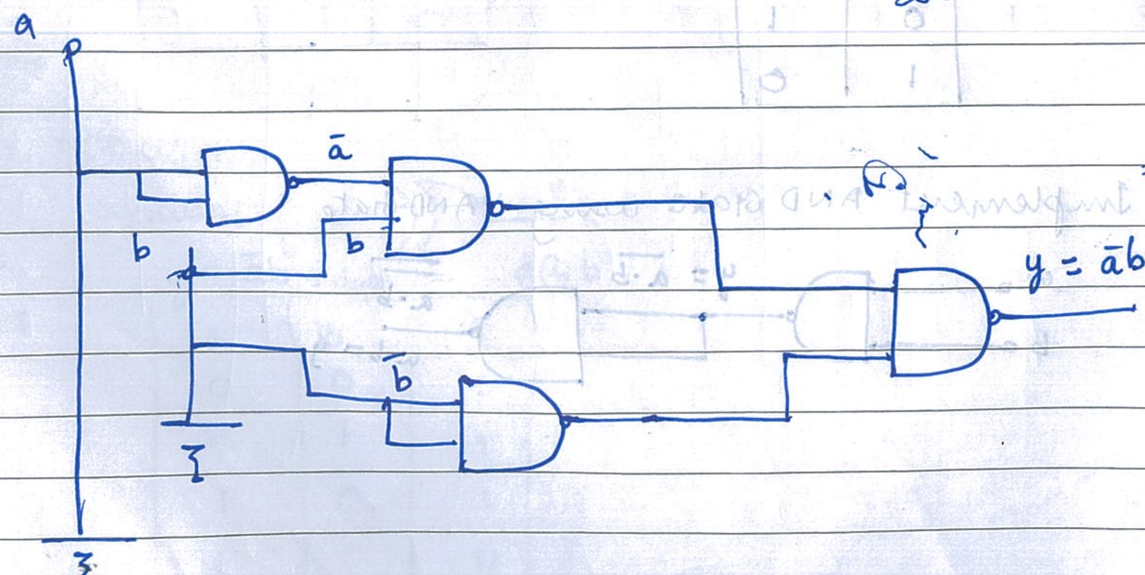


iv) Implement XOR Gate using NAND gate

$y = \bar{a}b + \bar{b}a$

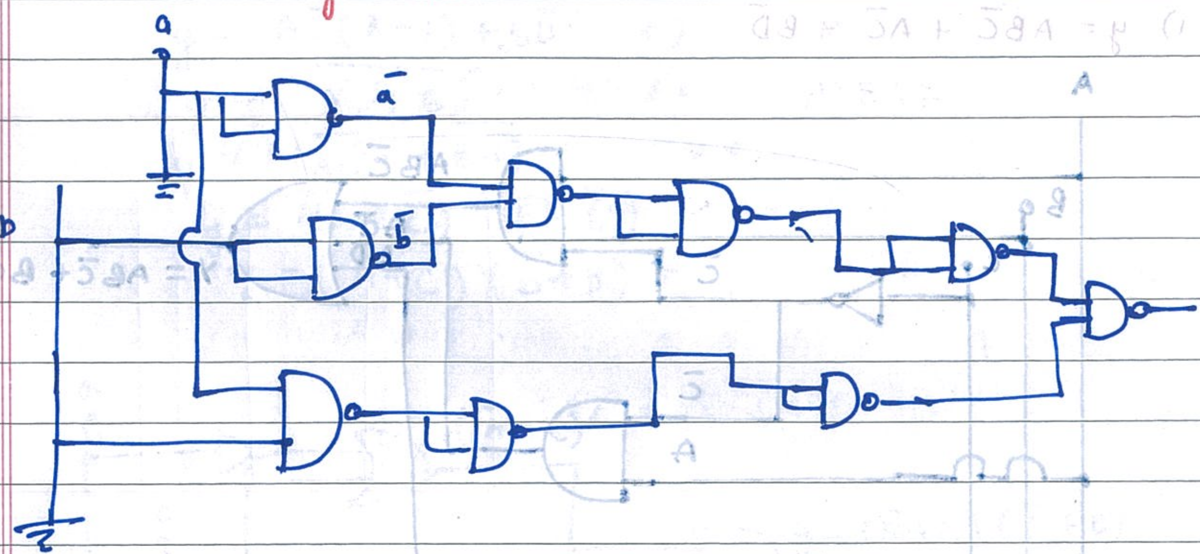


$y = x + z$



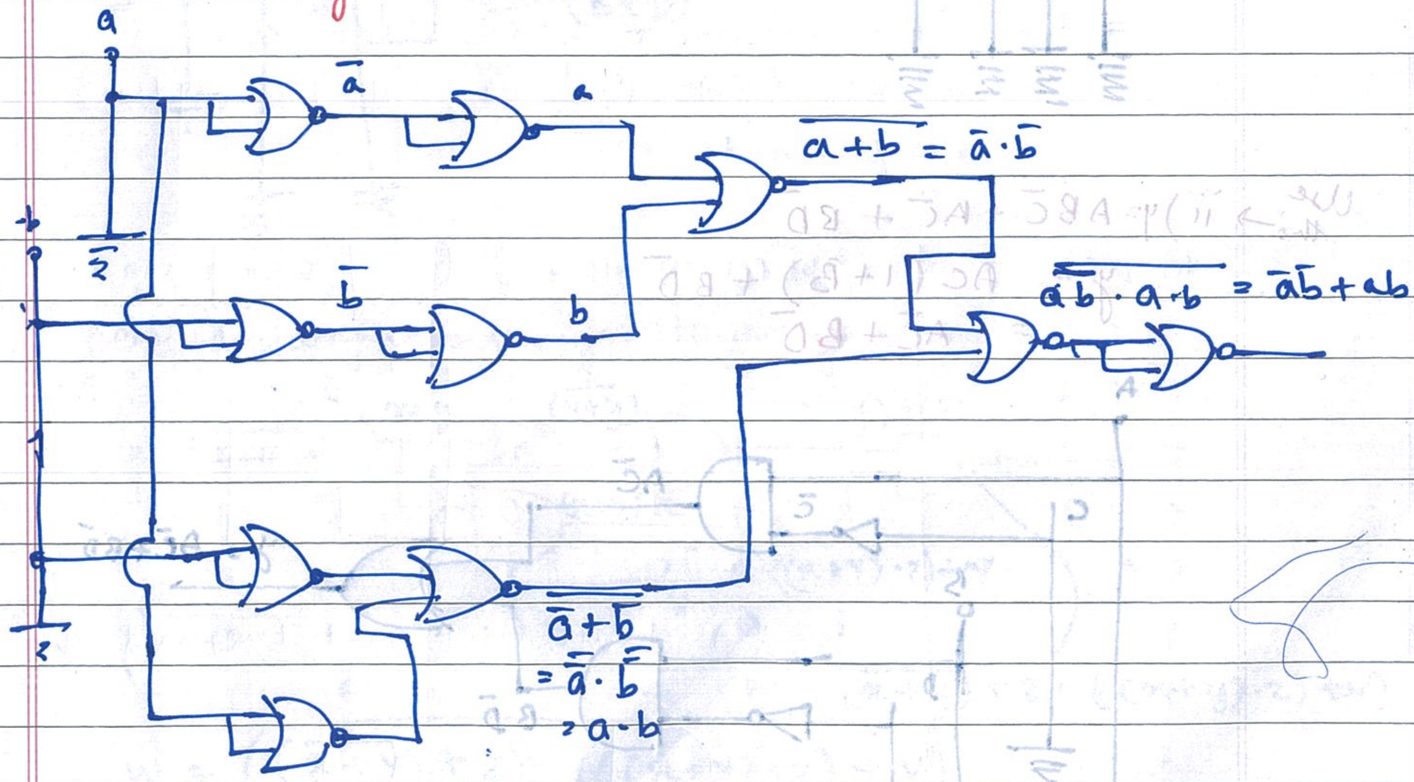
v) Implement XNOR Gate using NAND Gate

$y = \bar{a}\bar{b} + ab$



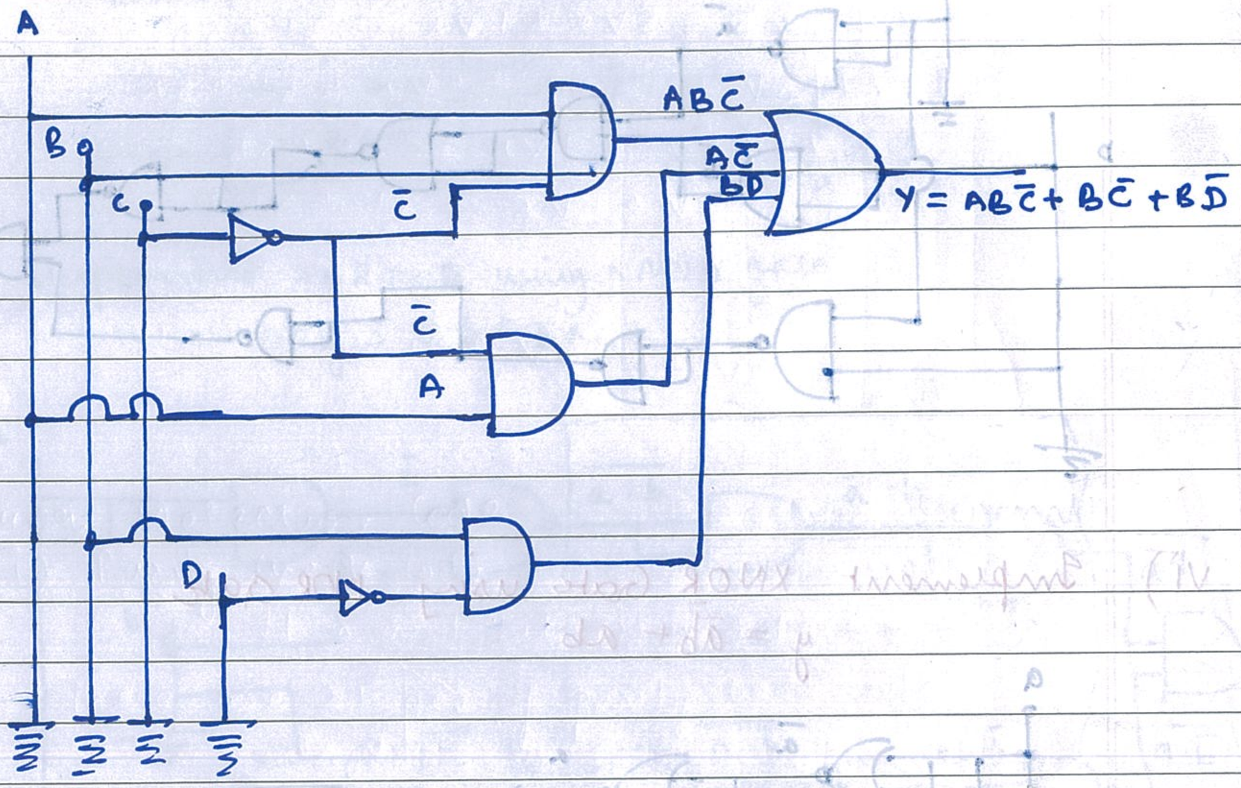
vi) Implement XNOR Gate using NOR gate

$y = \bar{a}\bar{b} + ab$



Logic Diagram from Boolean Expression

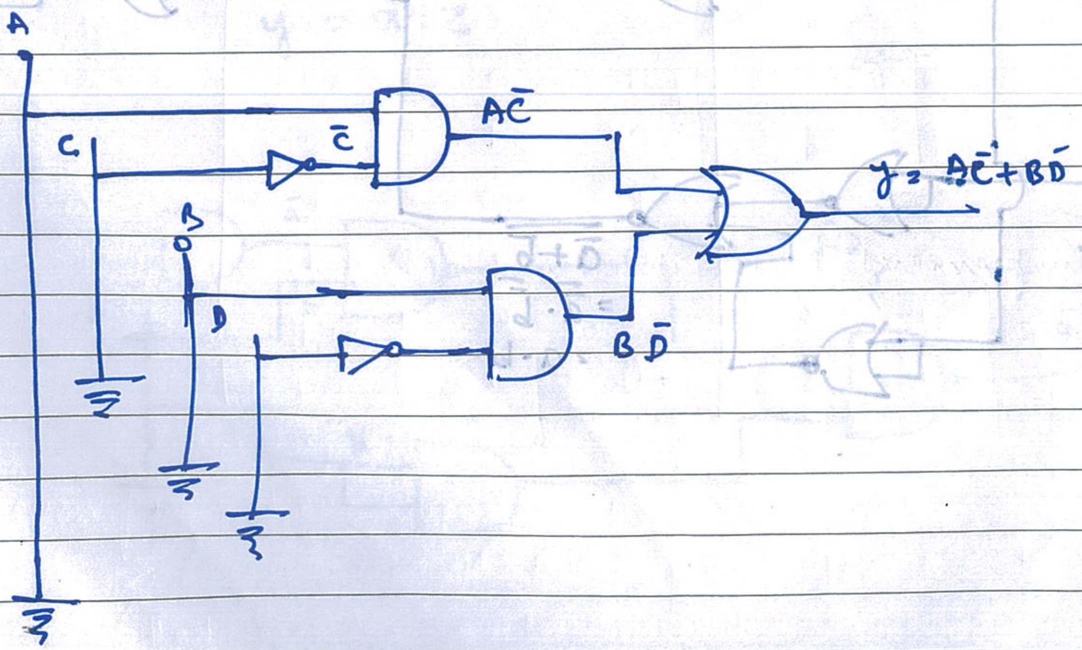
i) $y = AB\bar{C} + A\bar{C} + B\bar{D}$



Use this → ii) $y = AB\bar{C} + A\bar{C} + B\bar{D}$

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

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



iii) $y = \overline{AB\bar{C} + A\bar{C} + B\bar{D}}$

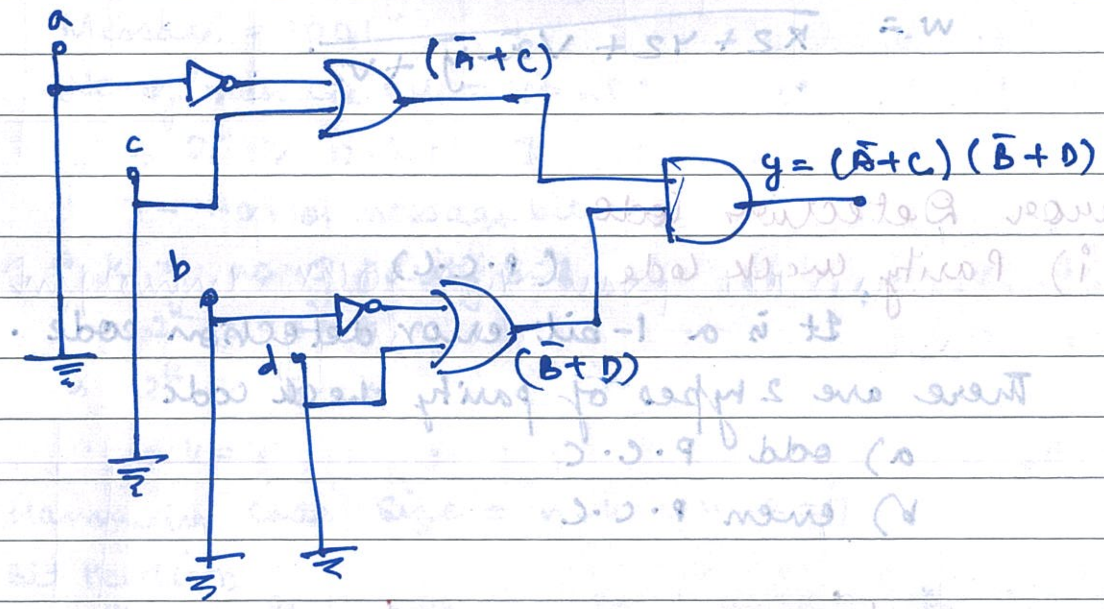
$y = \overline{A\bar{C}(B+1) + B\bar{D}}$

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

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

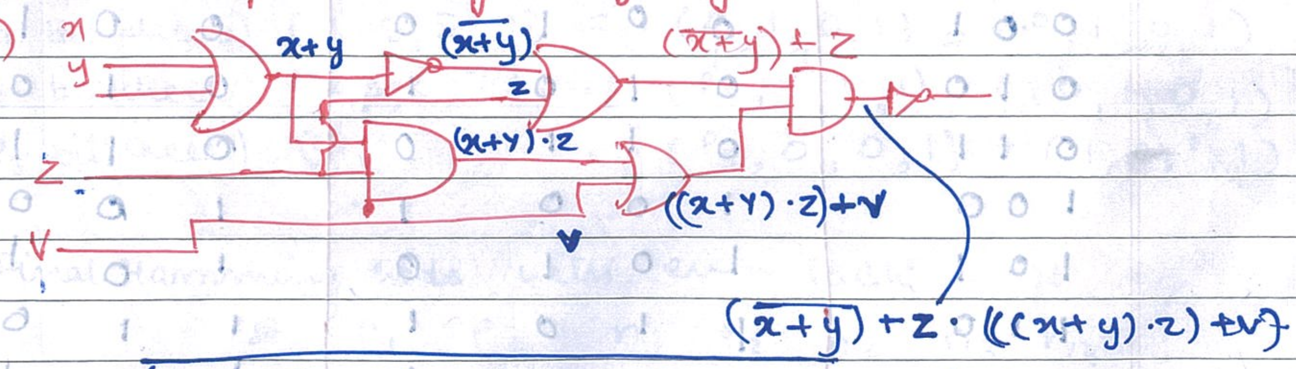
$y = (\bar{A} + \bar{\bar{C}})\ (\bar{B} + \bar{\bar{D}})$

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



Q. Boolean expression for logic gate

i)



$\overline{(\overline{x+y}) + z \cdot ((x+y)\cdot z) + v}$

$$W = \overline{((\overline{x+y}) + z) \cdot (((x+y)\cdot z) + v)}$$

$$\overline{(\bar{x}\cdot\bar{y} + z) \cdot (xz + yz + v)}$$

$$= (\overline{\bar{x}\bar{y} + z} + \overline{xz + yz + v})$$

$$= \overline{\bar{x}\bar{y}} \cdot \bar{z} + \overline{xz} \cdot \overline{yz} \cdot \bar{v}$$

$$= \bar{\bar{x}} + \bar{\bar{y}} \cdot \bar{z} + (\bar{x}+\bar{z}) \cdot (\bar{y}+\bar{z}) \cdot \bar{v}$$

$$= (x+y)\cdot\bar{z} + (\bar{x}+\bar{z}) \cdot v\bar{y} + v\bar{z}$$

$$= x\bar{z} + y\bar{z} + \bar{x}v\bar{y} + \bar{x}v\bar{z} + \bar{z}v\bar{y} + v\bar{z}$$

$$= x\bar{z} + y\bar{z} + \bar{x}v\bar{y} + \bar{x}v\bar{z} + v\bar{z}[1+\bar{y}]$$

$$= x\bar{z} + y\bar{z} + \bar{x}v\bar{y} + v\bar{z}[1+\bar{x}]$$

$$= x\bar{z} + y\bar{z} + \bar{x}v\bar{y} + v\bar{z}$$

or

$$w = \overline{xz + yz + v\bar{x}\cdot\bar{y} + vz}$$

Error Detection Code

i) Parity check code (P.C.C)

It is a 1-bit error detection code.

There are 2 types of parity check code

a) odd P.C.C

b) even P.C.C

MESSAGE x y z	ODD PARITY CHECK x	y	z	P	EVEN PARITY CHECK x	y	z	P
0 0 0	0	0	0	1	0	0	0	0
0 0 1	0	0	1	0	0	0	1	1
0 1 0	0	1	0	1	0	1	0	1
0 1 1	0	1	1	0	0	1	1	0
1 0 0	1	0	0	1	1	0	0	1
1 0 1	1	0	1	0	1	0	1	0
1 1 0	1	1	0	1	1	1	0	0
1 1 1	1	1	1	0	1	1	1	1

P → Parity Bit

In even parity check for the no. of one's in the transmitted message is even. In odd P.C.C check for the no. of one's in transmitted message is odd.

Limitations of Parity Check Code

1) In P.C.C we detect only signal bit error, but cannot correct the error

2) Error detection and correction code

a) Hamming Code

1) Hamming Code with Even Parity

2) Hamming Code with Odd Parity

Q1. Determine the single error code for the BCD No. 1001 using even parity.

Sol^n– Message = 1001

No. of message bit = 4 = n

⇒ $2^k \geq n+k+1$

⇒ n = No. of message bit

⇒ k = no. of parity bits

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

⇒ $2^k \geq 5+k$

⇒ k = 3

Hamming code size = n+k = 4+3 = 7

Bit Position

D_1 P_1	D_2 P_2	D_3 n_1	D_4 P_3	D_5 n_2	D_6 n_3	D_7 n_4
		1		0	0	1

(P_1 bit check) (1, 3, 5, 7) = (P_1, 1, 0, 1) = (0, 1, 0, 1)

(P_2 bit check) (2, 3, 6, 7) = (P_2, 1, 0, 1) = (0, 1, 0, 1)

(P_3 bit check) (4, 5, 6, 7) = (P_3, 0, 0, 1) = (1, 0, 0, 1)

Final Hamming code with even Parity

P_1	P_2	n_1	P_3	n_2	n_3	n_4
0	0	1	1	0	0	1

Q2 - Determine the single bit error detection and correction for BCD No - 10110 with odd Parity

Message = 10110

no. of message bit = n = 5

$2^k \geq k+n+1$

$2^k \geq k+5+1$

$2^k \geq k+6$

$k = 4$

to satisfy the condition

D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9
P_1	P_2	n_1	P_3	n_2	n_3	n_4	P_4	n_5
P_1	P_2	1	P_3	0	1	1	P_4	0

$(P_1, D_3, D_5, D_7, D_9) = (P_1, 1, 0, 1, 0) = (1, 1, 0, 1, 0)$

$(P_2, D_3, D_6, D_7) = (P_2, 1, 1, 1) = (0, 1, 1, 1)$

$(P_3, D_4, D_5, D_6, D_7) = (P_3, 0, 1, 1) = (1, 0, 1, 1)$

$(P_4, D_9) = (P_4, 0) = (1, 0)$

Final Code

P_1	P_2	n_1	P_3	n_2	n_3	n_4	P_4	n_5
1	0	1	1	0	1	1	1	0

BCD - 1101

Unit - II
Minimization Techniques

There are two types of expression :-

i) SOP → sum of Product → Min Term (m)

ii) POS → Product of Sum → Max Term (M)

$y = ABC + CA\bar{B}$ (MinTerm)

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

Digit	Variable A	B	C	Min Term SOP (m)	Max Terms (POS) (M)
0	0	0	0	$\bar{A}\bar{B}\bar{C}$ =	
1	0	0	1	$\bar{A}\bar{B}C$ =	
2	0	1	0	$\bar{A}B\bar{C}$ =	
3	0	1	1	$\bar{A}BC$ =	
4	1	0	0	$A\bar{B}\bar{C}$ =	
5	1	0	1	$A\bar{B}C$ =	
6	1	1	0	$AB\bar{C}$ =	
7	1	1	1	ABC	