13/Apr/2022

DIGITAL SYSTEMS

→ Number System conversions:

* Decimal (Base 10)
* Binary (Base 2)
* Octal (Base 8)
* Hexadecimal (Base 16)

→ BINARY — It has only 2 digits 0 & 1.
0 — no signal (false)
1 → signal present (true)
each digit is called bit.

4 bits = 1 nibble
8 bits = 1 byte

each digit rep. power of 2

→ OCTAL — It has 8 digits (0 to 7), each digit rep. power of 8.

$2^3 = 8$ | Therefore, three digits of binary can convert any octal → binary.
(3 binary digits = 1 octal digit)

used to shorten long binary nos.

→ DECIMAL — It has 10 digits (0–9). each digit rep. ~~Some~~ power of 10. It is used in day-to-day life. It can rep. any numeric value.

→ **HEXA-DECIMAL** – It has 16 digits (0 – 15)

0 – 9 are numbered same

10 – A
11 – B
12 – C
13 – D
14 – E
15 – F

each digit represents some power of 16.
As there are 16 bits $(2^4 = 16)$
~~four~~ (4 binary bits = 1 hexadecimal digit)

Also known as Alphanumeric Number System as it uses both digits as well as alphabets.

→ **Conversions**

1. Decimal to other number systems:

a) Decimal → Binary.

$(25)_{10}$ —— $( )_2$

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

$(11001)_2 = (25)_{10}$

b) Decimal → Octal. $(128)_{10} \rightarrow ( )_8$

8	128	0
8	16	0
8	2	2
	0	

$(200)_8 = (128)_{10}$

c) **Decimal to Hexadecimal**

$(128)_{10} \rightarrow (\ )_{16}$

16	128	0
16	8	8
	0	

$(128)_{10} = (80)_{16}$

→ Other bases to Decimal:

a) Binary to Decimal

$(1011)_2 \rightarrow (\ )_{10}$

1011

$1 * 2^0 = 1 \times 1 = 1$
$1 * 2^1 = 1 \times 2 = 2$
$0 * 2^2 = 0 \times 4 = 0$
$1 * 2^3 = 1 \times 8 = 8$

add

11

$(1011)_2 \rightarrow (11)_{10}$

1100

$0 * 2^0 = 0$
$0 * 2^1 = 0$
$1 * 2^2 = 4$
$1 * 2^3 = 8$

12

$(1101)_2 = (12)_{10}$

b) Octal → Decimal

$(22)_8 \rightarrow (\ )_{10}$

D B O H

$3+2+1=6$

22

$2 * 8^0 = 2 \times 1 = 2$
$2 * 8^1 = 2 \times 8 = 16$ (+)
18

$(22)_8 \rightarrow (18)_{10}$

c) Hexadecimal → Decimal.

$(121)_{16} \rightarrow (?)_{10}$

121

$1 * 16^0 = 1 \times 1 = 1$
$2 * 16^1 = 2 \times 16 = 32$
$1 * 16^2 = 1 \times 256 = 256$
289

$(121)_{16} \rightarrow (289)_{10}$

→ HexaDecimal → Binary.

$(89)_{16} \rightarrow (\ )_2$

$8 = 1000$
$9 = 1001$
$(89)_{16} = (10001001)_2$

convert each (0-9) & (A-F) digit seperately into binary and join them.

→ Octal → Binary.

$(214)_8 \rightarrow (\ )_2$

$2 = 010$
$1 = 001$
$4 = 100$

$(214)_8 = (010001100)_2$

covert each digit seperately and join them together.

→ Binary → Octal / Hexadecimal

Step1 = Binary → Decimal
Step2 = Decimal → Octal / Hexadecimal

dif

→ Octal → Hexadecimal
Step1: Octal → Decimal
Step2: Decimal → Hexadecimal

Hexadecimal → Octal

← $\boxed{\text{Converse}}$

→ Point conversions :

$(452.52)_{10} \rightarrow (\ )_2$

2	452	0
2	226	0
2	113	1
2	56	0
2	28	0
2	14	0
2	7	1
2	3	1
	1	

111000100

0.52 x 2	= 1.04	1
0.04 x 2	= 0.08	0
0.08 x 2	= 0.16	0
0.16 x 2	= 0.32	0
	= 0.64	0
	= 1.28	1
0.28 x 2	= 0.56	0
	= 1.12	1
0.12 x 2	= 0.24	0

	$= 0.48$	0
	$= 0.96$	0
	$= 1.92$	1
0.92×2	$= 1.84$	1
0.84×2	$= 1.68$	1
0.68×2	$= 1.36$	1
0.36×2	$= 0.$	

⇒ Octal

0.625
~~0.125~~ 0.625
0.25

$1 \quad 0.4 \quad \frac{1}{16}$, $\frac{4+1}{16}$

$(198.3281)_{10} \rightarrow (\quad)_2$

2	198	0
2	99	1
2	49	1
2	24	0
2	12	0
2	6	0
2	3	1
	1	

$(11000110.010101)_2$

Ans

0.3281×2	$= 0.6562$	0
0.6562×2	$= 1.3124$	1
0.3124×2	$= 0.6248$	0
0.6248×2	$= 1.2496$	1
0.2496×2	$= 0.4992$	0
0.4992×2	$= 0.9984 \approx 1$	1
~~0.9984×2~~	~~$= 1.9968$~~	

→ Binary point to decimal:

1011.0101

$2^3\ 2^2\ 2^1\ 2^0 \ . \ 2^{-1}\ 2^{-2}\ 2^{-3}\ 2^{-4}$

$8+0+2+1 \ . \ 0.25+0.0625$

11 . 375

0.2500
0.0625
0.3125

→ Binary to decimal :

0.500
0.125
0.0625
0.6875

$110011 \cdot 1011$

$51 \cdot (0.5 + 0.125 + 0.0625)$

$(51.6875)_{10} \rightarrow (\ )_{8}$

8	51	3
	6	

(63)

$0.6875 \times 8 = 5.5000$ 5

$0.5 \times 8 = 4.0$ 4

$(63.54)_{8}$

→ Binary weighted / Non-weighted codes;

In weighted code, each digit/symbol/position of number signifies a specific weight!

Some B.-Weighted code are: Binary, decimal, Octal, Hexadecimal, etc.

1) BCD code (Binary coded Decimal code)

Various BCD codes — 8421, 2421, 5211, etc.

a) 8421 code :

8 4 2 1
1 0 0 1

93 = (1001) (0011)
= 10010011

b) 2421 code:

94

↓ ↓

$\underset{2421}{(1011)}\underset{2421}{(0100)} = 11110100$

c) 5211 code:

94

↓ ↓

$\underset{5211}{(1111)}\ \underset{5211}{(0111)} = 11110111$

→ Binary Non-weighted code: codes in which each digit ~~is not~~ doesn't signifies specific weight are called binary non-weighted codes.

eg: Excess-3 code, Gray code, etc.
Alphanumeric codes.

1. Excess-3 code

(i) Add 3 to each digit, then convert each digit to binary form and join them together.

48 ⇒ $(01111011)_{Excess-3}$

+3 +3

↓ ↓

7 11

↓ ↓

0111 1011

2. Gray Code: (Minimum change code) (Unit distance code) bcoz for every number only one bit differs.

dig

3. Alphanumeric codes: 26 alphabets, 0-9 digits, and other symbols.

(used worldwide) 7-bit — ASCII — American standard code for info interchange

8-bit (used in large IBM computers) — EBCDIC — Extended binary coded Decimal interchange code.

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* Binary → Gray code

$b_0\, b_1\, b_2\, b_3\, b_4\, b_5$

1 1 1 0 1 0

↓

1 0 0 1 1 1

$(111010)_2 \rightarrow (100111)_{gray}$.

1. MSB → same
2. all other bits $= b_i \oplus b_{i-1}$

---

* Gray code → Binary

$(100111)_{gray} \rightarrow (\ )_2$

1 0 0 1 1 1

1 1 1 0 1 0

$(100111)_{gray} = (111010)_2$

1. MSB → same
2. all other bits $= ans_{i-1} \oplus b_i$

234
123
357

→ ~~Excess-3~~ Decimal → Excess-3

$9 + 3 = 12$

4 bit

$2^3 = 8$ (0–7)

$2^4 = 16$ (0–15)

(1) $(23)_{10} \rightarrow (\ )_{excess\text{-}3}$

2 3 + 3 3 → 56

(0101) (0110)

$(01010110)_{excess\text{-}3}$

(2) $(15.46)_{10} \rightarrow (\ )_{excess\text{-}3}$

15.46 + 33.33 → 48.79

(0100)(1000).(0111)(1001)

Ans: 01001000.01111001

→ Excess-3 ~~to~~ Decimal:

1. Divide in 4 bit parts.
2. Subtract 011(3) from every part
3. then convert to decimal

→ Signed Numbers:

value

Sign: 1011001 = -25

0 – +ve

1 – -ve

terchange

change

18/Apr/22

Question Bank

1. Universal gates — NAND & NOR

Advantages:

easily available, easy to fabricate, economical

It can implement any boolean function without the need/use of other logic gates.

2. Classification of Number System:

* Binary - Base 2 (Digits: 0,1), understood by computer directly.
* Decimal - Base 10 (digits: 0 to 9), used in day-to-day life.
* Octal - Base 8 (digits: 0 to 7), used to reduce the size of nos. rep. in binary form ($2^3 = 8$)
  ∴ 3 bits in binary form = 1 bit in octal.
* Hexadecimal - Base 16 (digits: 0 - 15), 0-9 rep. same and others as:

  10 - A, 11 - B, 12 - C, 13 - D, 14 - E, 15 - F

  also used to reduce long binary nos. to small hexadecimal (4 bits binary = 1 hexa-decimal bit) (bcoz $2^4 = 16$)

~~3. Diminished radix complement~~

7. find x, $(211)_x = (152)_8$

↓ decimal

$(211)_x = 2 \times x^2 + 1 \times x^1 + 1 \times x^0 = 2x^2 + x + 1$

$(152)_8 = 1 \times 8^2 + 5 \times 8^1 + 2 \times 8^0 = 64 + 40 + 2$

$= 106$

$$2x^2 + x + 1 = 106$$
$$2x^2 + x - 105 = 0$$
$$x = \frac{-1 \pm \sqrt{1+840}}{4}$$

29

841 (900) 30

$\begin{array}{r} 29 \\ 29 \\ \hline 3\cancel{6}/81 \\ 841 \end{array}$

$$x = \frac{-1 \pm 29}{4} \Rightarrow x = \cancel{\frac{-1+29}{4}}\,7, \cancel{\frac{-1-29}{4}}$$

$$\boxed{x = 7}$$

(8) ~~What~~ Binary logic — It is the basis of ~~digital~~ electronic systems, such as cell phones, computers, etc. It works on 0's & 1's. It involves addition, subtraction, multiplication, division of 0's & 1's. It also includes logic gate fns, AND, OR, NOT, which translates input signals into specific output.

(9) (i) $(163.789)_{10} \rightarrow (\ )_8$

decimal

8	163	3
8	20	4
	2	

$(243)_8$

fractional

	carry
$0.789 \times 8 = 6.312$	6
$0.312 \times 8 = 2.496$	2
$0.5 \times 8 = 4.0$	4

$(.624)_8$

Ans $(243.624)_8$

(ii) $(11001101.0101)_2 \longrightarrow (\ )_8 \ / \ (\ )_4$

$2^3 = 8$ (3 bits) $\qquad 2^2 = 4$ (2 bits)

011 001 101 . 010 100
3 1 5 . 2 4

Ans $(315.24)_8$

11 00 11 01 . 01 01
3 0 3 1 . 1 1

Ans $(3031.11)_4$

1024 × 4
4096
2

(iii) $(4567)_{10} \longrightarrow (\ )_2$

2	4567	1
2	2283	1
2	1141	1
2	570	0
2	285	1
2	142	0
2	71	1
2	35	1
2	17	1
2	8	0
2	4	0
2	2	0
	1	

13 bits

$(1000111010111)_2$

(iv) $(4D.56)_{16} \rightarrow (\ )_2$

(0100)(1101)(0101)(0110)

$(01001101.01010110)_2$

10. 1) $(2ED)_{16} = (\ )_8 = (\ )_2$

$(2ED)_{16} \rightarrow (\ )_{10}$

2 E D

$13 \times 16^0 = 013$

$14 \times 16^1 = 224$

$2 \times 16^2 = 512$

749

16
14
1/40/24
224

$(749)_{10} \rightarrow (\ )_8 \rightarrow (\ )_2$

$(1355)_8 \rightarrow (\ )_2$ 3bits each

$(001011101101)_2$

8	749	5
8	93	5
8	11	3
	1	

$(1355)_8$

2	749	1
2	374	0
2	187	1
2	93	1
2	46	0
2	23	1
	11	

2	11	1
2	5	1
2	2	0
	1	

$(1011101101)_2$

ii) $(250.5)_{10} \rightarrow (\ )_8 \rightarrow (\ )_4$

8	250	2
8	31	7
	3	

fractional

$0.5 \times 8 = 4.0$ | carry 4.

$(372.4)_8$

4	250	2
4	62	2
4	15	3
	3	

$0.5 \times 4 = 2.0$ | carry 2

$(3322.2)_4$

iii) $(38)_9 = (\ )_5 = (\ )_2$

38

$8 \times 9^0 = 8$

$3 \times 9^1 = 27$

35

$(35)_{10} \rightarrow (\ )_5 \rightarrow (\ )_2$

5	35	0
5	7	2
	1	

Ans $(120)_5$

2	35	1
2	17	1
2	8	0
2	4	0
2	2	0
	1	

Ans (100011)

$$\begin{array}{r} 49 \\ \times 5 \\ \hline 245 \end{array}$$

(iv) $(516)_7 = (\ )_{10} = (\ )_{16}$

516

$6 \times 7^0 = 006$

$1 \times 7^1 = 007$

$5 \times 7^2 = 245$

$= 258$

Ans $(258)_{10} \rightarrow (\ )_{16}$

$$\begin{array}{r|r|l} 16 & 258 & 2 \\ \hline 16 & 16 & 0 \\ \hline & 1 & \end{array}$$

Ans $(102)_{16}$

(11.) Rep: 3452 in i) BCD ii) Excess-3.

Bcd 3452 = $(0011\,0100\,0101\,0010)_{BCD}$

(0011)(0100)(0101)(0010)

Ans

excess-3

3452 = 6785

+3 +3 +3 +3

(0110)(0111)(1000)(0101)

Ans $(0110\,0111\,1000\,0101)_{excess-3}$

(12.) State & Explain Demorgan's Theorem.

Demorgan's Theorem states that 2 (or more) variables NOR'ed together is equal to 2 variables (or more) inverted and AND'ed together.

Whereas, 2nd ~~the~~ statement states that 2 variables NAND'ed together is equal to the variables inverted & OR'ed.

1. $\overline{(A\cdot B)} = \overline{A}+\overline{B}$ and,
2. $\overline{(A+B)} = \overline{A}\cdot\overline{B}$

~~proof~~ Using Truth Table:

equal H.P.

1.

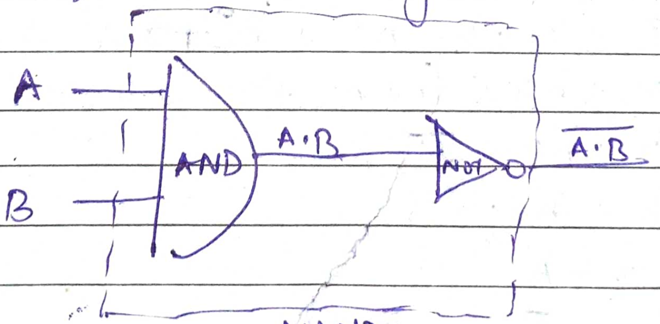
A	B	$A\cdot B$	$\overline{(A\cdot B)}$	$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

2.

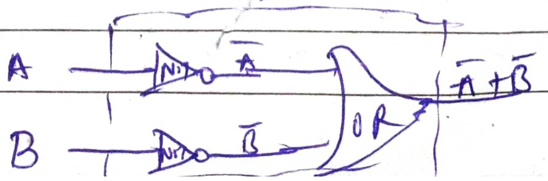
A	B	$A+B$	$\overline{(A+B)}$	$\overline{A}$	$\overline{B}$	$\overline{A}\cdot\overline{B}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

equal H.P.

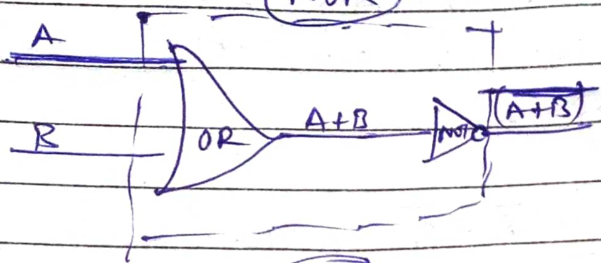
* ~~Using Boolean laws~~ logic circuit diagrams:



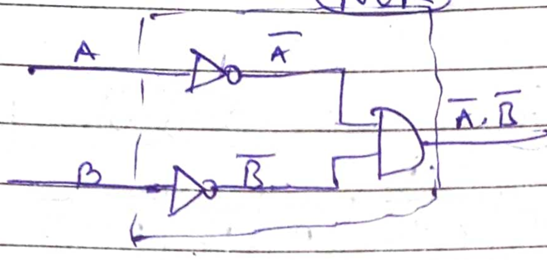
NAND



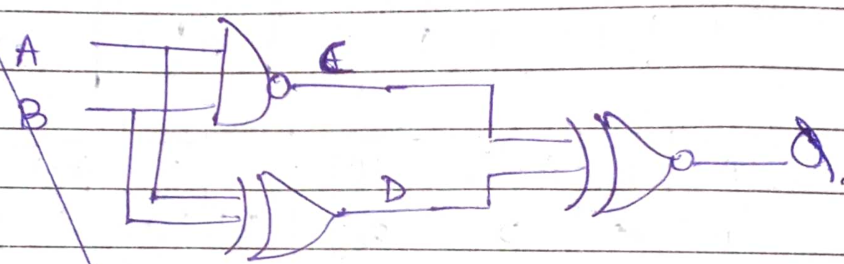
NOR



NOR



→ Practise



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

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

$Q = \overline{C \oplus D} = (\overline{\bar{A}+\bar{B}}) \cdot (\overline{A\bar{B}+B\bar{A}}) + (\bar{A}+\bar{B})(A\bar{B}+B\bar{A})$

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

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

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

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

$= A\bar{B} + \bar{A}(\underbrace{B+\bar{B}}_{1})$

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

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

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

AB

Imp * A

Proof using boolean laws :

To prove ~~that~~ the demorgens theorem , we know

(1) $(x+y)' = x' \cdot y'$

(2) $(x \cdot y)' = x' + y'$

that , $A + A' = 1$ & $A \cdot \bar{A} = 0$

for statement (1) :

$x + y = A$

$\bar{x}\bar{y} = A'$

$\boxed{A + \bar{A} = 1}$

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

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

$x + xy + \bar{x}y + \bar{x}\bar{y}$

$x(\cancel{1+y})^{1} + \bar{x}(\cancel{y+\bar{y}})^{1}$

$x + \bar{x} = 1$

H.P.

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

$(x+y)(\bar{x}\bar{y}) = \cancel{x\bar{x}}\bar{y} + \cancel{y}\bar{x}\bar{y}$ (comp law)

$= 0 + 0 = 0$

H.P

for statement (2) ;

$A + \bar{A}' = 1$ & $A \cdot \bar{A} = 0$

$xy = A$

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

$xy + \bar{x} + \bar{y}$

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

$xy + \bar{x} + x\bar{y} + \bar{x}\bar{y}$

$x(\cancel{y+\bar{y}})^{1} + \bar{x}(\cancel{1+\bar{y}})^{1}$

$x + \bar{x} = 1$

H.P.

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

$\cancel{x\bar{x}}y^{0} + x\cancel{y\bar{y}}^{0} = 0 + 0$

$= 0$

H.P.

Date: Page:

(14) Associative / Distributive law:

(1.) $(A+B)+C = A+(B+C)$ [Associative]

$(AB).C = A.(BC)$

(2.) $A.(B+C) = AB + AC$ (AND over OR)

$A+(B.C) = (A+B).(A+C)$ (OR over AND)

dif

(14.) $(198)_{12} + (12121)_3 = (\ )_8$

198

$8 \times 12^0 = 08$

$9 \times 12^1 = 108$

$1 \times 12^2 = 144$

$(260)_{10}$

12121

$1 \times 3^0 = 1$

$2 \times 3^1 = 6$

$1 \times 3^2 = 9$

$2 \times 3^3 = 54$

$1 \times 3^4 = 81$

$(151)_{10}$

$(260)_{10} + (150)_{10} = (410)_{10}$

8	410	2
8	51	3
	6	

$(632)_8$ Ans.

(15.) 1) Same as 9(1) Ans $(163.789)_{10} \rightarrow (243.624)_8$

$(163.789)_{10} \rightarrow (\ )_{16}$

16	163	3
	10	(A)

$(A3)_{16}$

0.789×16 12 (C)

0.594×16 9

$0.5 \times 16 =$ 8

7.86, 4.734, 12.624, 1.734, 1.88, 5.94, 3.56, 9.50

Ans $(A3.C98)_{16}$

11) Same as 9(11)

18. $(103)_4 + (50)_7 = (\quad)_9$

$(16+0+3)_{10} + (5\times7)_{10} = (54)_{10}$

$(19)_{10} + (35)_{10}$

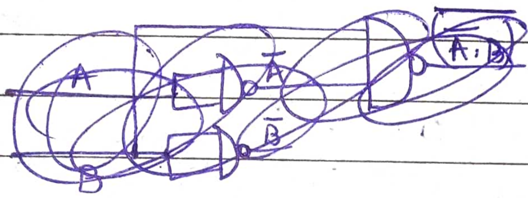
$$\begin{array}{c|c|c} 9 & 54 & 0 \\ \hline & 6 & \end{array}$$

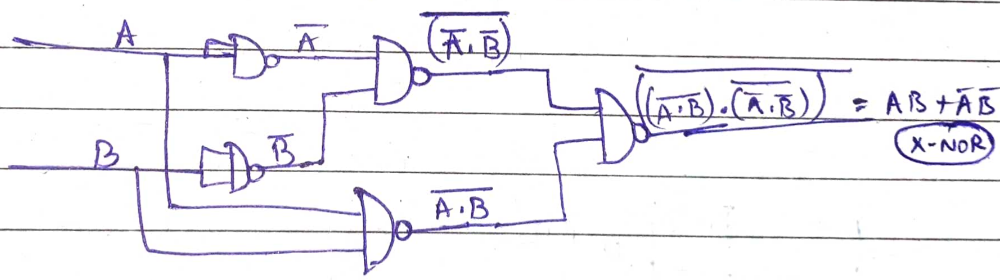
$\Rightarrow (60)_9$ Ans.

19. $A \odot B$ (X-NOR) $= \overline{A \oplus B}$ (X-OR) $= \overline{(A\bar{B} + \bar{A}B)} = \overline{(A\bar{B})}\cdot\overline{(\bar{A}B)}$

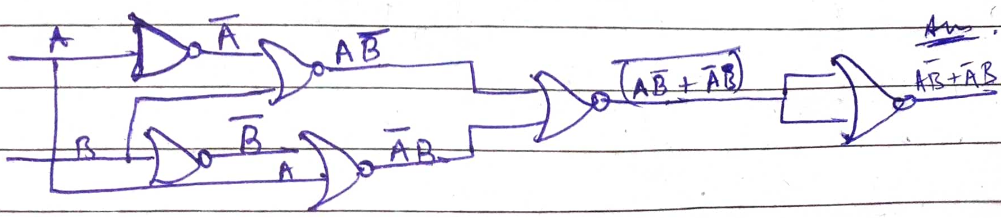
$= (\bar{A}+B)\cdot(A+\bar{B}) = \bar{A}\bar{B} + AB$

$\overline{\overline{(\bar{A}\cdot\bar{B})}\cdot\overline{(AB)}}$





20. $A \oplus B = \bar{A}B + A\bar{B} = \overline{\overline{\bar{A}B}\cdot\overline{A\bar{B}}}$



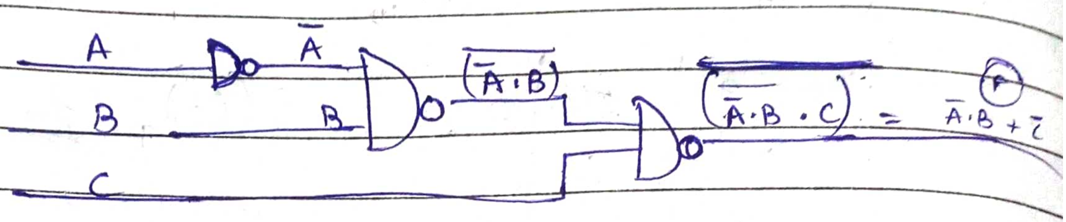
22. $F = AB\bar{C} + \bar{A}B + A\bar{B}\bar{C} + \bar{A}\bar{C}$

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

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

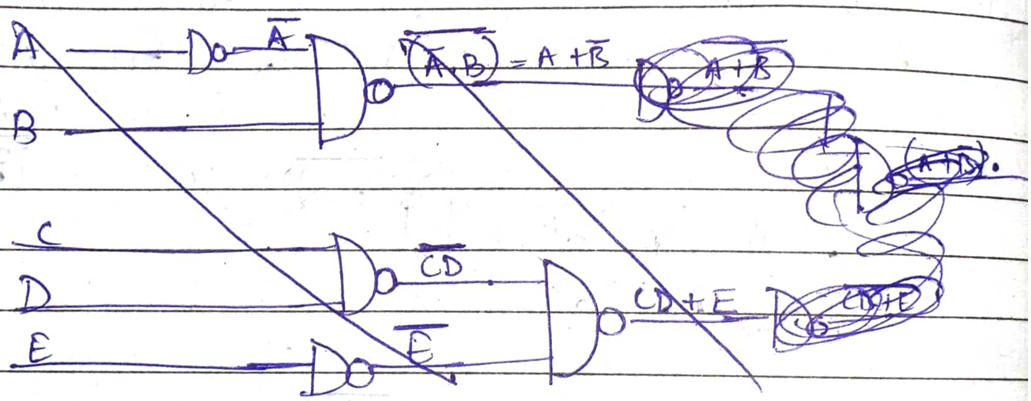
$= \bar{A}B + \bar{C}(\cancel{A + \bar{A}})^{1}$

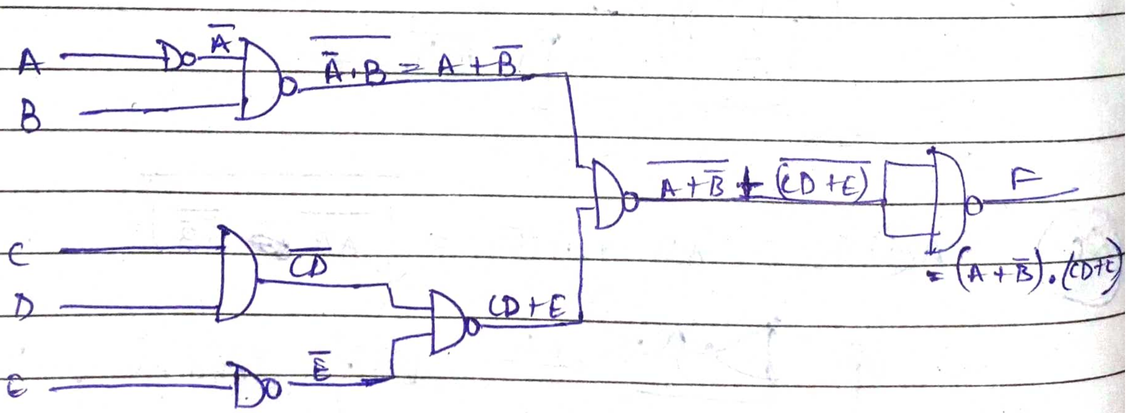
$= \bar{A}B + \bar{C}$



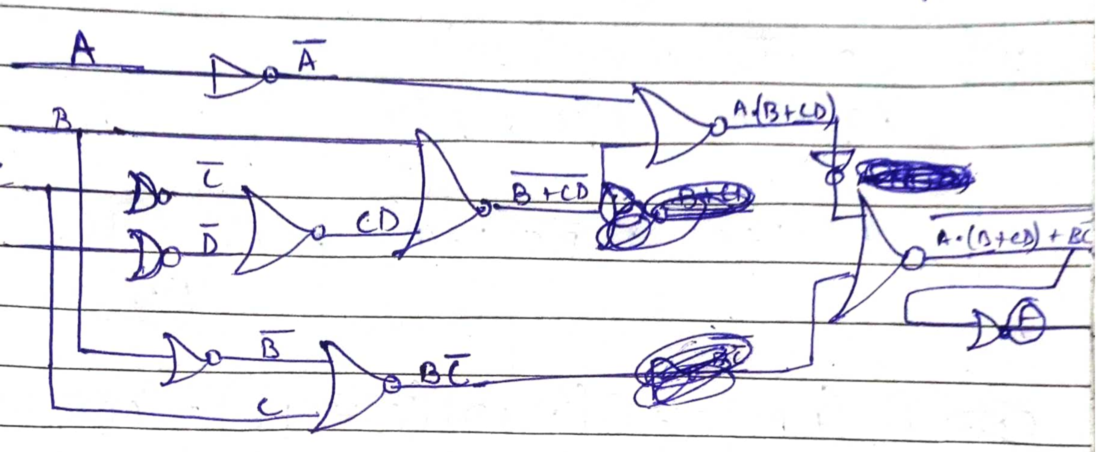
23. $F = (A+\bar{B})(CD+E)$

a) $= ACD + AE + \bar{B}CD + \bar{B}E$



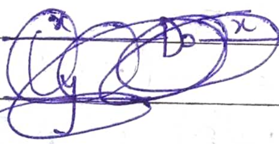


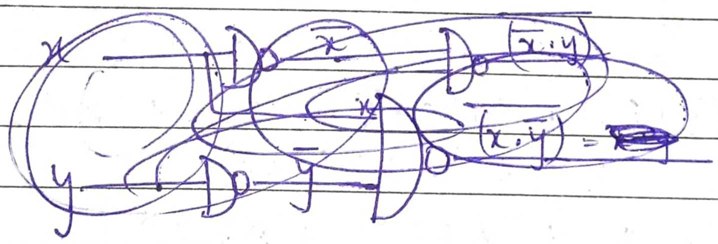
b) $F = A(B+CD) + B\overline{C}$ (NOR gates)



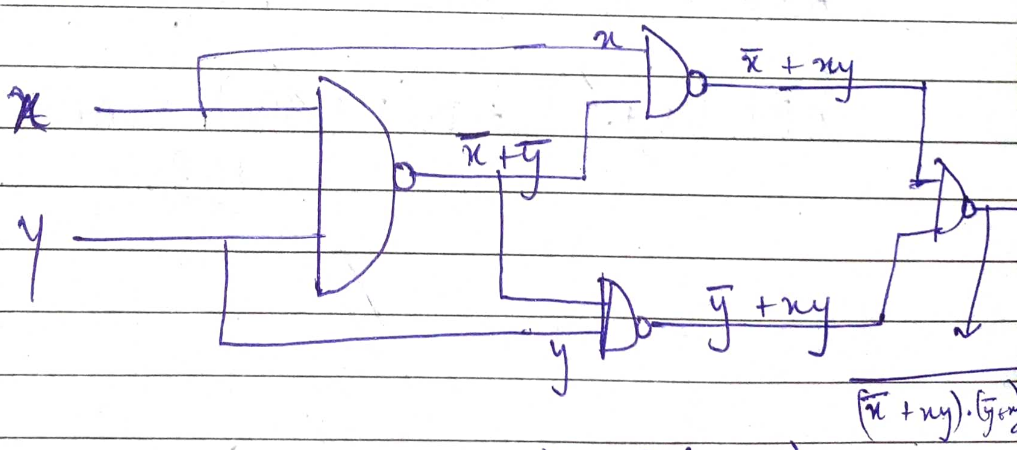
c) $F = \overline{x}y + x\overline{y}$ (4 NAND gates)

$F = \overline{x}y + x\overline{y} = x \oplus y$





$\overline{x}+y + x+\overline{y}$



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

$= x\overline{y} + \overline{x}y$ = Ans

a)

24. $AB + \bar{B}C + AC = AB + \bar{B}C$.

LHS: $AB + \bar{B}C + AC(B+\bar{B})$

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

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

H.P

25. b) $(AB+C+D)(\bar{C}+D)(\bar{C}+D+E) = AB\bar{C}+D$

$(AB\bar{C} + ABD + CD + \bar{C}D + D)(\bar{C}+D+E)$

$AB\bar{C} + AB\bar{C}D + AB\bar{C}E + ABD + ABDE + CD + CDE$
$+ \bar{C}D + \bar{C}DE + D + DE$

$AB\bar{C}(1+\cancel{D}) + ABD(1+\cancel{E}) + CD(1+\cancel{E})$
$+ \bar{C}D(1+\cancel{E}) + D(1+\cancel{E}) + AB\bar{C}E$

$AB\bar{C} + ABD + CD + \bar{C}D + D + AB\bar{C}E$

$AB\bar{C}(1+\cancel{E}) + D(C+\cancel{\bar{C}}) + D + ABD$

$AB\bar{C} + D + ABD(C+\bar{C})$

$AB\bar{C} + D + AB\bar{C}D + ABCD$

$AB\bar{C}(1+\cancel{D}) + D(1+\cancel{ABC}) = AB\bar{C} + D$

H.P

26. c) $\overline{(\overline{A+B}) \cdot (\overline{A}+\overline{B})} = 0$

LHS: $(\overline{A}\cdot\overline{B})(\bar{A}\cdot B)$ [De - Morgans]

$= 0$ $\quad a \cdot \bar{a} = 0$ [Complement]

$\cancel{\overline{A}\cdot\overline{B}\cdot\overline{A} + \overline{A}\cdot\overline{B}\cdot\overline{B}}$ ~~[Distributive]~~

$\cancel{\overline{A}\cdot\overline{B} + \overline{A}\cdot\overline{B}}$ H.P.

27. $(103)_6 + (50)_7 = (\ )_9$ (Same as 18)

28. $(211)_b = (152)_8$ (Same as 7.)

$(152)_8 = (1\times 8^2 + 5\times 8^1 + 2\times 8^0)_{10}$

$= (64 + 40 + 2) = (106)_{10}$

$(211)_b = (2\times b^2 + 1\times b + 1\times 1)$

$= 2b^2 + b + 1$

$2b^2 + b + 1 = 106$

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

$b = \dfrac{-1 \pm \sqrt{1+280}}{4}$ (quadratic formula)

$= \dfrac{-1 \pm 29}{4} = \dfrac{28}{4}, \dfrac{-30}{4}$

7

$\boxed{b = 7}$

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

Truth table :

Same

A	B	C	A+B	A+C	(A+B).(A+C)	B.C	A+BC
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	1	0	0	0	0
0	1	1	1	1	1	1	1
1	0	0	1	1	1	0	1
1	0	1	1	1	1	0	1
1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1

H.P. equal.