Introduction To Digital System

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Question Bank.

Ques-1.> Which gates are called as the universal gates? What are its advantages?

Ans.> A universal gate is a gate which can implement any boolean function without need to use any other gate type.

The NAND and NOR gates are called as the universal gates.
The advantages of NAND and NOR gates are economical and easier to fabricate and the basic gates used in all IC digital logic families.

Ques-2.> Explain classification of Number System.

Sol Classification of Number system :-

(i) Decimal Number :- Decimal number system has base 10 as it uses 10 digits, 0,1,2,3,4,5,6,7,8,9

(ii) Binary Number System :- Binary number system has base 2 as it uses two digits, 0 and 1.

(iii) Octal Number System :- It has base 8 and uses 8 digits 0,1,2,3,4,5,6,7.

(iv) Hexadecimal Number System :- It has base 16 and uses 10 digits and 6 letters, 0,1,2,3,4,5,6,7,8,9, A,B,C,D,E,F.

Ques-3.> Explain about diminished radix complement.

Ans.> If r is the base of the number system, then there are two types of complements that are possible i.e., r's and (r-1)'s.
The r's complement is known as the Radix

complement and (r-1)'s complement is known as Diminished Radix Complement.

$$r\text{'s complement} = (r^n)_{10} - N$$
$$(r-1)\text{'s complement} = \{(r^n)_{10} - 1\} - N$$

where, n = number of digits in number.
N = given number.
r = radix or base of the number.

Ques-4.) What is meant by parity bit?
Ans.) A parity bit is an extra bit added to a string of data bits in order to detect any error that might have crept into it while it was being stored or processed and moved from one place to another in a digital system.

Ques-5.) Define duality property.
Ans.) According to this property, if we have postulates or theorems of Boolean Algebra for one type of operation then that operation can be converted into another type of operation (i.e., AND can be converted to OR and vice-versa) just by interchanging '0 with 1', '1 with 0', '(+) sign with (.) sign' and '(.) sign with (+) sign'.

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Ques-6.> Perform (-50) - (-10) in binary using the signed 2's complement.

Solve:>

$$(-50)_{10} - (-10)_{10}$$
$$= (-50)_{10} + (10)_{10}$$

First convert these numbers in binary.

$(-50)_{10}$

2	50	0
2	25	1
2	12	0
2	6	0
2	3	1
2	1	1
	0	

$\therefore (-50)_{10} = (-110010)_2$

$(10)_{10}$

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

$\therefore (10)_{10} = (1010)_2$

Now, $(-50)_{10} + (10)_{10}$

$= (-110010)_2 + (1010)_2$

$= 1010 = X$ (Let)

$-110010 = Y$ (Let)

Using 2's complement;

$X = 1010$

2's complement of Y = $+001110$

011000

There is no end carry.

$X - Y = -$ (2's complement of 011000

$= (-101000)_2$

Convert it in decimal.

$= -[1\times2^5 + 0\times2^4 + 1\times2^3 + 0\times2^2 + 0\times2^1 + 0\times2^0]$

$= (-40)_{10}$

Hence, $(-50) - (-10) = -40$

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Ques-7) Determine the value of base x if $(211)_x = (152)_8$.

Ans.) $(211)_x = (152)_8$ ——— (I)

Convert both into decimal system

$$2\times x^2 + 1\times x^1 + 1\times x^0 = 1\times 8^2 + 5\times 8^1 + 2\times 8^0$$

$$2x^2 + x + 1 = 64 + 40 + 2$$

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

$$2x^2 + 15x - 14x - 105 = 0$$

$$x(2x+15) - 7(2x+15) = 0$$

$$(x-7)(2x+15) = 0$$

$$(x-7) = 0 \quad , \quad (2x+15) = 0$$

$$x = 7 \quad , \quad x = \frac{-15}{2} \text{ (neglected)}.$$

$\therefore x = 7$, which satisfies the eq^n(I)

$$2\times 7^2 + 1\times 7^1 + 1\times 7^0 = 1\times 8^2 + 5\times 8^1 + 2\times 8^0$$

$$98 + 7 + 1 = 64 + 40 + 2.$$

$$106 = 106$$

Hence, the value of base x is 7.

Ques-8) Define binary logic.

Ans.) Binary logic is the basis of electronic systems, such as computers and cell phones.
Binary logic consists of binary variables and logical operations. The variables are designated by the alphabets such as A, B, x, y, etc. with each variable having only two distinct values: 1 & 0.
It includes logic gate functions - AND, OR, and NOT which translates input signals into specific output.

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Ques-9:> Convert the following numbers:

(i) $(163.789)_{10}$ to Octal number.

(ii) $(11001101.0101)_2$ to base-8 and base-4.

(iii) $(4567)_{10}$ to base-2.

(iv) $(4D.56)_{16}$ to binary.

Ans.> (i) $(163.789)_{10}$ to Octal Number.

Real Part :-

$(163)_{10}$

Using Division Method,

8	163	3
8	20	4
8	2	2
	0	

Fractional Part :-

$(0.789)_{10}$

Using Multiplication Method,

$0.789 \times 8 = 6.312$

$0.312 \times 8 = 2.496$

$0.496 \times 8 = 3.968$

$0.968 \times 8 = 7.744$

$0.744 \times 8 = 5.952$

$0.952 \times 8 = 7.616$

$0.616 \times 8 = 4.928$

$0.928 \times 8 = 7.424$

$0.424 \times 8 = 3.392$

$= (243.623757473)_8$.

(ii) $(11001101.0101)_2$ to base-8 and base-4.

Firstly convert it into decimal number system,

$= 1\times2^7 + 1\times2^6 + 0\times2^5 + 0\times2^4 + 1\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0 + 0\times2^{-1} + 1\times2^{-2} + 0\times2^{-3} + 1\times2^{-4}$.

$= 2^7 + 2^6 + 2^3 + 2^2 + 1 + \frac{1}{4} + \frac{1}{16}$

$= 128 + 64 + 8 + 4 + 1 + \frac{4+1}{16}$

$= 205 + 0.3125$

$= 205.3125$

$\therefore (11001101.0101)_2 = (205.3125)_{10}$

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Now, Convert $(205.3125)_{10}$ to base-8.

Real Part:-

$(205)_{10}$

Using Division Method,

8	205	5
8	25	9
8	2	2
	0	

Fractional Part:-

$(0.3125)_{10}$

Using Multiplication Method

$0.3125 \times 8 = 2.5$

$0.5 \times 8 = 4$

$= (295.24)_8$

$\therefore (11001101.0101)_2 = (295.24)_8.$

For Base-4

And, Convert $(205.3125)_{10}$ to base-4.

Real Part:-

$(205)_{10}$

Using Division Method,

4	205	1
4	51	3
4	12	0
4	3	3
	0	

Fractional Part:-

$(0.3125)_{10}$

Using Multiplication Method.

$0.3125 \times 4 = 1.25$

$0.25 \times 4 = 1$

$= (3031.11)_4$

$(11001101.0101)_2 = (3031.11)_4.$

(iv) $(4D.56)_{16}$ to Binary.

Firstly, convert it into decimal number system

$= 4 \times 16^1 + 13 \times 16^0 + 5 \times 16^{-1} + 6 \times 16^{-2}$

$= 64 + 13 + \frac{5}{16} + \frac{6}{256}$

$= 77 + \frac{80+6}{256} = 77 + 0.3359375$

$= 77.3359375 \quad \therefore (4D.56)_{16} = (77.3359375)_{10}$

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For base 2,
Convert $(77.3359375)_{10}$ to binary

Real Part :-
Using division method,

2	77	1
2	38	0
2	19	1
2	9	1
2	4	0
2	2	0
2	1	1
	0	

Fractional Part :-
Using Multiplication method,

$0.3359375 \times 2 = 0.671875$
$0.671875 \times 2 = 1.34375$
$0.34375 \times 2 = 0.6875$
$0.6875 \times 2 = 1.375$
$0.375 \times 2 = 0.75$
$0.75 \times 2 = 1.5$
$0.5 \times 2 = 1$

$\therefore = (1001101.0101011)_2$

$\therefore (4D.56)_{16} = (1001101.0101011)_2$.

(iii) $(4567)_{10}$ to base 2.

Real Part :-
Using Division Method,

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
2	1	1
	0	

$= (1000111010111)_2$

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Ques-10) Do as directed:

(a) $(2ED)_{16} = ( )_8 = ( )_2$

(b) $(250.5)_{10} = ( )_8 = ( )_4$

(c) $(38)_9 = ( )_5 = ( )_2$

(d) $(516)_7 = ( )_{10} = ( )_{16}$

Ans.) (a) $(2ED)_{16} = ( )_8 = ( )_2$

First convert $(2ED)_{16}$ in decimal number system

$= 2\times16^2 + 14\times16^1 + 13\times16^0$

$= 2\times256 + 14\times16 + 13$

$= 512 + 224 + 13$

$= 749$

$\therefore (2ED)_{16} = (749)_{10}$

Now, For base 8,

Using Division Method,

8	749	5
8	93	5
8	11	3
8	1	1
	0	

$\therefore (2ED)_{16} = (1355)_8$

And, For base 2,

Using Division Method,

2	749	1
2	374	0
2	187	1
2	93	1
2	46	0
2	23	1
2	11	1
2	5	1
2	2	0
2	1	1
	0	

$= (1011101101)_2$

$\therefore (2ED)_{16} = (1011101101)_2$

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$\therefore (2ED)_{16} = (1355)_8 = (1011101101)_2$.

(b) $(250.5)_{10} = (\ )_8 = (\ )_4$.

For base 8,

Real Part :-

Using Division Method,

8	250	2
8	31	7
8	3	3
	0	

Fractional Part:-

Using Multiplication Method,

$0.5 \times 8 = 4$

$= (372.4)_8$

$\therefore (250.5)_{10} = (372.4)_8$

And, For base 4,

Real Part :-

Using Division Method,

4	250	2
4	62	2
4	15	3
4	3	3
	0	

Fractional Part:-

Using Multiplication Method,

$0.5 \times 4 = 2$

$= (3322.2)_4$

$\therefore (250.5)_{10} = (3322.2)_4$

Hence, $(250.5)_{10} = (372.4)_8 = (3322.2)_4$.

(c) $(38)_9 = (\ )_5 = (\ )_2$.

First, convert $(38)_9$ in decimal number system,

$= 3 \times 9^1 + 8 \times 9^0$

$= 27 + 8$

$= 35$

$\therefore (38)_9 = (35)_{10}$

For base 5

Using Division Method,

5	35	0
5	7	2
5	1	1
	0	

$= (120)_5$

$\therefore (38)_9 = (120)_5$

For base 2,
Using Division Method,

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

$= (100011)_2$

$\therefore (38)_9 = (100011)_2$

Hence, $(38)_9 = (120)_5 = (100011)_2$

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

For base-10

$= 5 \times 7^2 + 1 \times 7^1 + 6 \times 7^0$

$= 5 \times 49 + 1 \times 7 + 6 \times 1$

$= 245 + 7 + 6$

$= 258$

$\therefore (516)_7 = (258)_{10}$

For base-16,
Using Division Method,

16	258	2
16	16	0
16	1	1
	0	

$= (102)_{16}$

$\therefore (516)_7 = (102)_{16}$

Hence, $(516)_7 = (258)_{10} = (102)_{16}$

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Ques-11.> Represent the decimal number 3452 in
(i) BCD (ii) Excess-3.

Ans.> (i) The decimal number 3452 equivalent in the BCD code number system represent as 0011 0100 0101 0010.

As, 3 → 0011
4 → 0100
5 → 0101
2 → 0010

Hence, For 3452 → 0011010001010010.

(ii) For Excess 3-code.

3	4	5	2
+3	+3	+3	+3
6	7	8	5
0110	0111	1000	0101

The decimal number 3452 equivalent in Excess 3-code represent as 0110 0111 1000 0101.

Ques-12.> State and explain the De Morgan's Theorem.

Ans.> De Morgan's Theorem:-
De Morgan's Theorems are basically two sets of rules developed from the boolean expressions for AND, OR and NOT using two input variables A and B.

→ De Morgan's First Theorem:-
De Morgan's First Theorem states that the compliment of a logical sum equals the logical product of the complements.

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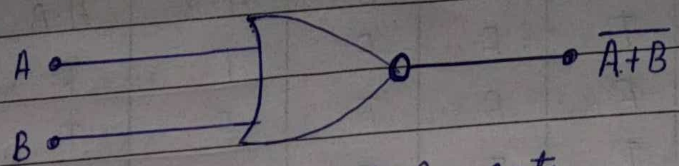
Logic Equation:- $\overline{A+B} = \bar{A}\cdot\bar{B}$

Using logic gates,

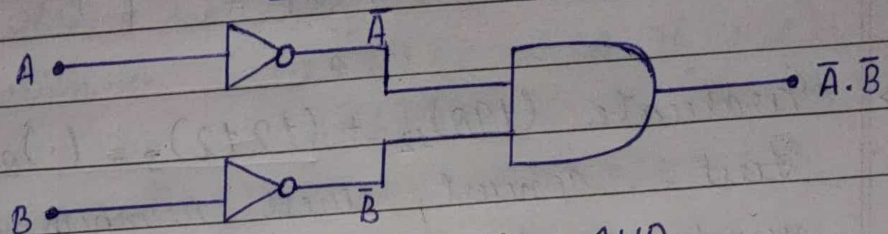
L.H.S.



NOR gate

$\equiv$

R.H.S.



Negative-AND.

Using Truth Table:-

A	B	$\bar{A}$	$\bar{B}$	$A+B$	$\overline{A+B}$	$\bar{A}\cdot\bar{B}$
T	T	F	F	T	F	F
T	F	F	T	T	F	F
F	T	T	F	T	F	F
F	F	T	T	F	T	T

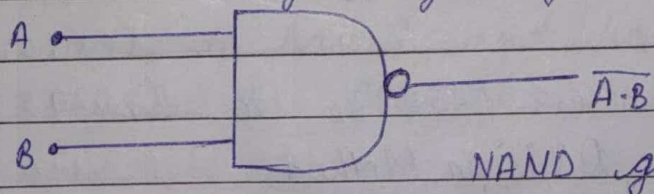
De Morgan's Second Theorem:-

De Morgan's Second Theorem states that the complement of a logical product equals the logical sum of the complement.

Logic Equation:- $\overline{A\cdot B} = \bar{A}+\bar{B}$

Using logic gates

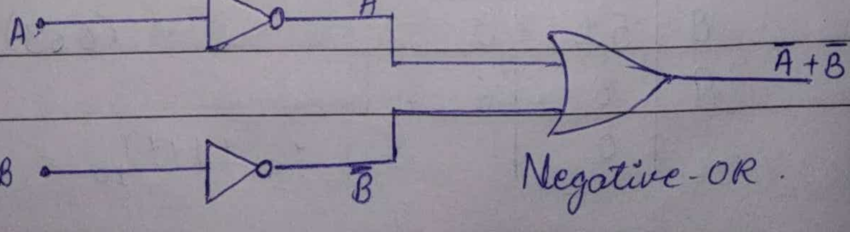
L.H.S. →



NAND gate

$\equiv$

R.H.S. →



Negative-OR.

Using Truth Table:

A	B	$\bar{A}$	$\bar{B}$	A·B	$\overline{A \cdot B}$	$\bar{A}+\bar{B}$
T	T	F	F	T	F	F
T	F	F	T	F	T	T
F	T	T	F	F	T	T
F	F	T	T	F	T	T

Ques. 13.> Evaluate $(198)_{12} + (1212)_3 = (\cdot)_8$

Ans.> First, convert these numbers in decimal number system.

→ $(198)_{12}$

$= 1 \times 12^2 + 9 \times 12^1 + 8 \times 12^0$

$= 144 + 108 + 8$

$= 260$

$\therefore \quad (198)_{12} = (260)_{10}$ ---- (I)

→ $(12121)_3$

$= 1 \times 3^4 + 2 \times 3^3 + 1 \times 3^2 + 2 \times 3^1 + 1 \times 3^0$

$= 81 + 54 + 9 + 6 + 1$

$= 151$

$\therefore \quad (12121)_3 = (151)_{10}$ ---- (II)

Now, $(198)_{12} + (12121)_3$

$= (260)_{10} + (151)_{10}$ {∵ From eqⁿ (I) & (II)}

$= (411)_{10}$

And, Convert $(411)_{10}$ to base 8

Using Division Method,

8	411	3
8	51	3
8	6	6
	0	

$= (633)_8$

$\therefore \quad (411)_{10} = (633)_8$

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Hence, $(198)_{12} + (1212)_3 = (633)_8$.

Ques-14) Define Associative Law and Distributive Law.

Ans:) Associative Law :- The associative law states that when any three real numbers are added or multiplied, then the grouping (or association) of the numbers does not effect the result.

Representation :- $(a+b)+c = a+(b+c)$.
$(a\times b)\times c = a\times(b\times c)$.

Example :- $(5+7)+3 = 5+(7+3)$
$12+3 = 5+10$
$15 = 15$.

Distributive Law :- The distributive law states that when a factor is multiplied by sum of two terms, it is essential to multiply each of the two numbers by the factor and finally perform the addition.

Representation :- $A(B+C) = AB+AC$.

Example :- $6(5+3) = 6\times5 + 6\times3$
$6\times8 = 30+18$
$48 = 48$.

Ques-15) Convert the following numbers

(a) $(163.789)_{10}$ to Octal number and Hexadecimal Number.

(b) $(11001101.0101)_2$ to base 8 and base 4.

Ans:) (a) $(163.789)_{10}$ to Octal Number and Hexadecimal Number.

For Octal Number,

Real Part :-
Using Division Method,

8	163	3
8	20	4
8	2	2
	0	

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Fractional Part :-
Using Multiplication Method,

$0.789 \times 8 = 6.312$
$0.312 \times 8 = 2.496$
$0.496 \times 8 = 3.968$
$0.968 \times 8 = 7.744$
$0.744 \times 8 = 5.952$
$0.952 \times 8 = 7.616$
$0.616 \times 8 = 4.928$
$0.928 \times 8 = 7.424$
$0.424 \times 8 = 3.392$
$0.392 \times 8 = 3.136$
$0.136 \times 8 = 1.088$
$0.088 \times 8 = 0.704$

$\therefore (163.789)_{10} = (243.623757473310)_8$

For hexadecimal number,

Real Part :-
Using Division Method,

16	163	3
16	10	10
	0	

Fractional Part :-
Using Multiplication Method,

$0.789 \times 16 = 12.624$
$0.624 \times 16 = 9.984$
$0.984 \times 16 = 15.744$
$0.744 \times 16 = 11.904$
$0.904 \times 16 = 14.464$
$0.464 \times 16 = 7.424$
$0.424 \times 16 = 6.784$
$0.784 \times 16 = 12.544$
$0.544 \times 16 = 8.704$
$0.704 \times 16 = 11.264$
$0.264 \times 16 = 4.224$

$(163.789)_{10} = 10\ 3 . 12\ 9\ 15\ 11\ 14\ 7\ 6\ 12\ 8\ 11\ 4$
$(163.789)_{10} = (A3.C9FBE76C8B4)_{16}$

Hence, $(163.789)_{10} = (243.623757473310)_8 = (A3.C9FBE76C8B4)_{16}$

(b) $(11001101 \cdot 0101)_2$ to base 8 and base 4.

First, Convert this binary number to decimal number.

$= 1\times2^7 + 1\times2^6 + 0\times2^5 + 0\times2^4 + 1\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0 + 0\times2^{-1} + 1\times2^{-2} + 0\times2^{-3} + 1\times2^{-4}$.

$= 128 + 64 + 8 + 4 + 1 + \frac{1}{4} + \frac{1}{16}$

$= 205 + \frac{4+1}{16}$

$= 205 + 0.3125$

$= (205.3125)_{10}$

$\therefore (11001101 \cdot 0101)_2 = (205.3125)_{10}$

For base-8,

Real Part :-

Using Division Method,

8	205	5
8	25	1
8	3	3
	0	

Fractional Part :-

Using Multiplication Method,

$0.3125 \times 8 = 2.5$

$0.5 \times 8 = 4$

$= (315.24)_8$

$\therefore (11001101 \cdot 0101)_2 = (315 \cdot 24)_8$

For base-4,

Real Part :-

Using Division Method,

4	205	1
4	51	3
4	12	0
4	3	3
	0	

Fractional Part :-

Using Multiplication Method,

$0.3125 \times 4 = 1.25$

$0.25 \times 4 = 1$

$= (3031 \cdot 11)_4$

$\therefore (11001101 \cdot 0101)_2 = (3031 \cdot 11)_4$

Hence, $(11001101 \cdot 0101)_2 = (315.24)_8 = (3031 \cdot 11)_4$

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Ques-16.> Given the two binary numbers X = 1010101 and Y = 1001011, perform the subtraction X − Y using 2's complement.

Ans.> X = 1010101
Y = 1001011

X − Y = 1010101 − 1001011

The subtraction X − Y using 2's complement,

$$
\begin{array}{rr}
X = & 1010101 \\
\text{2's complement of } Y = & +\,0110101 \\
\hline
 & 1\,0001010
\end{array}
$$

Carry

Omit the carry.

Hence, X − Y using 2's complement = 0001010.

Ques-17.> Subtract (111001) from (101011) using 2's complement.

Ans.> Subtract (111001) from (101011) using 2's complement,

Here, X = 111001 and Y = 101011

Now, Subtract X from Y using 2's complement.

$$
\begin{array}{rr}
Y = & 101011 \\
\text{2's complement of } X = & +\,000111 \\
\hline
 & 110010
\end{array}
$$

There is no end carry.

X − Y = − (2's complement of 110010)

= − 001110.

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Ques-18) Evaluate $(103)_4 + (50)_7 = (\ )_9$.

Ans:) First, convert these numbers in decimal number system.

→ $(103)_4$

$= 1\times4^2 + 0\times4^1 + 3\times4^0$

$= 16 + 0 + 3$

$= 19$

$\therefore (103)_4 = (19)_{10}$ --- (I)

→ $(50)_7$

$= 5\times7^1 + 0\times7^0$

$= 35$

$\therefore (50)_7 = (35)_{10}$ --- (II)

Now, $(103)_4 + (50)_7$

$= (19)_{10} + (35)_{10}$ {∵ From eqⁿ(I) &(II)}.

$= (54)_{10}$

And Convert $(54)_{10}$ to base-9.

9	54	0
9	6	6
	0	

$= (60)_9$

$\therefore (54)_{10} = (60)_9$.

Hence, $(103)_4 + (50)_7 = (60)_9$.

Ques-19) Realize 2 input X-NOR gate using NAND gates only.

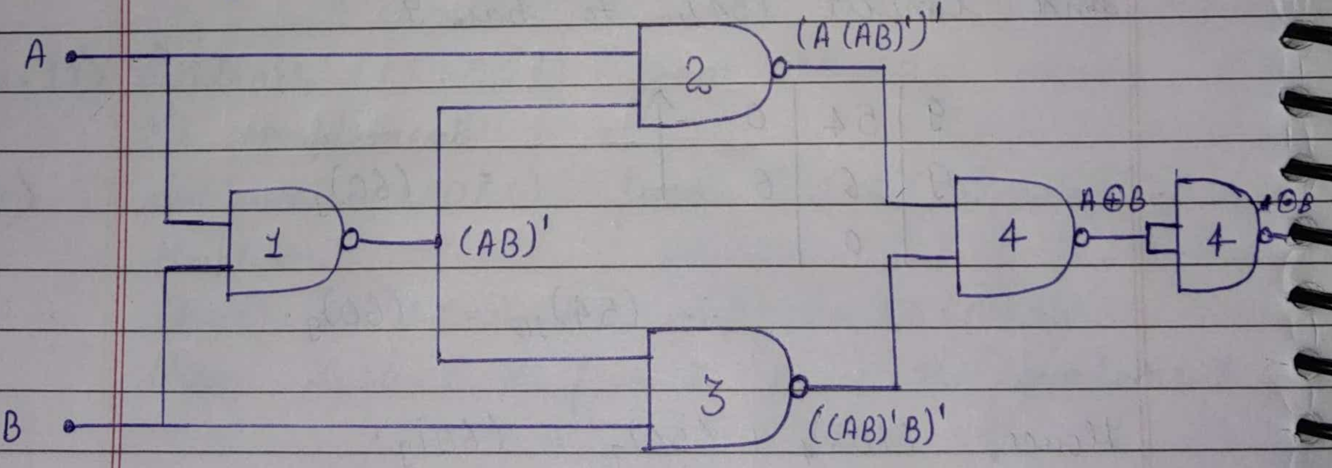
Ans:) The output of two input X-NOR gate using NAND gate is shown by $Y = AB' + A'B$. This can be achieved with logic diagram.

Gate No.	Inputs	Outputs
1	A, B	$(AB)'$
2	$A, (AB)'$	$(A(AB)')'$
3	$(AB)', B$	$((AB)'B)'$
4	$(A(AB)')', ((AB)'B)'$	$A'B + AB'$

Now, the output from gate no. 4 is the overall output of the configuration.

$$Y = ((A(AB)')'((AB)'B)')'$$
$$Y = (A(AB)')'' + ((AB)'B)'' \quad \{\because \text{Using De Morgan's}\}$$
$$Y = A(AB)' + (AB)'B$$
$$Y = A(A'+B') + (A'+B')B \quad \{\because \text{Using De Morgan's}\}$$
$$Y = AA' + AB' + A'B + B'B$$
$$Y = 0 + AB' + A'B + 0 \quad \{\because PP' = P'P = 0\}$$
$$Y = A'B + AB'$$

Using logic diagram,



The output of X-OR gate to a NOT gate is that of an X-NOR gate.

Ques-20> Realize 2 input X-OR gate using NOR gates only.

Ans.> The output of 2 input XOR gate using NOR gates is shown by $Y = AB + A'B'$.

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Gate No.	Input	Output
1	A, B	$(A+B)'$
2	$A, (A+B)'$	$(A+(A+B)')'$
3	$(A+B)', B$	$((A+B)'+B)'$
4	$(A+(A+B)')', ((A+B)'+B)'$	$AB + A'B'$

Now, the output from gate no. 4 is the overall output of the configuration.

$$Y = ((A+(A+B)')' + ((A+B)'+B)')'$$

$$= ((A+(A+B)')'' \cdot ((A+B)'+B)''$$ {∵ Using De Morga

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

$$= (A+(A' \cdot B')) \cdot ((A' \cdot B')+B)$$ {∵ Using De Morgan's

$$= (A+A')(A+B')(A'+B)(B'+B)$$ {∵ Distributive Law

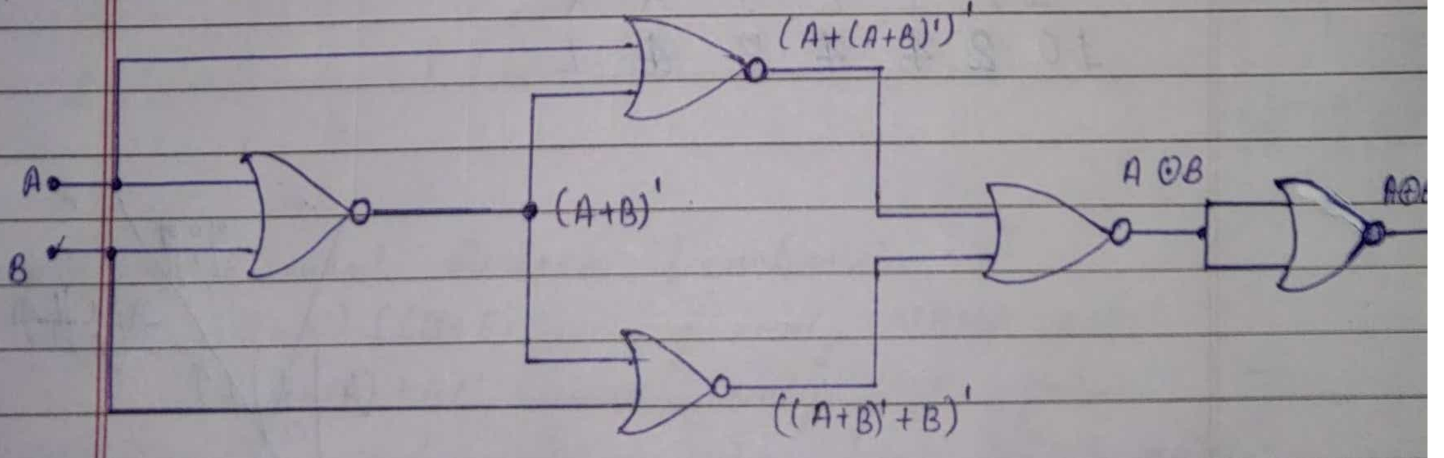
$$= 1\ (A+B')(A'+B) \cdot 1$$ {∵ $P+P'=1$}.

$$= AA' + AB + B'A' + B'B$$ {∵ Distributive Law

$$= 0 + AB + B'A' + 0$$ {∵ $PP'=0$}.

$$Y = AB + A'B'$$

Using logic diagram,



The output of X-NOR gate to a NOT is that of an X-OR gate.

Ques-21:> Multiply these numbers in the given base without converting to decimal:

(a) $(135)_6$ and $(43)_6$

(b) $(121)_3$ and $(12121)_3$

Ans:>

~~Steps for Co~~

(a)

$$\begin{array}{r} 1\ 3\ 5 \\ \times\ 4\ 3 \\ \hline 4\ 5\ 3 \\ 1\ 0\ 3\ 2\ \times \\ \hline 1\ 1\ 2\ 1\ 3 \\ \hline \end{array}$$

(b)

$$\begin{array}{r} 1\ 2\ 1\ 2\ 1 \\ \times\ 1\ 2\ 1 \\ \hline 1\ 2\ 1\ 2\ 1 \\ 1\ 0\ 2\ 0\ 1\ 2\ \times \\ 1\ 2\ 1\ 2\ 1\ \times\ \times \\ \hline 1\ 0\ 0\ 2\ 2\ 1\ 1\ 1 \\ \hline \end{array}$$

Date:

Ques-22> Design the circuit by using NAND gates

$$F = ABC' + A'B + AB'C' + A'C'.$$

Ans.>

$$F = ABC' + A'B + AB'C' + A'C'$$

$$= ABC' + AB'C' + A'B + A'C'$$

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

$$= AC' \times 1 + A'B + A'C' \quad \{\because P+P' = 1\}.$$

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

$$= C' \times 1 + A'B \quad \{\because P+P' = 1\}$$

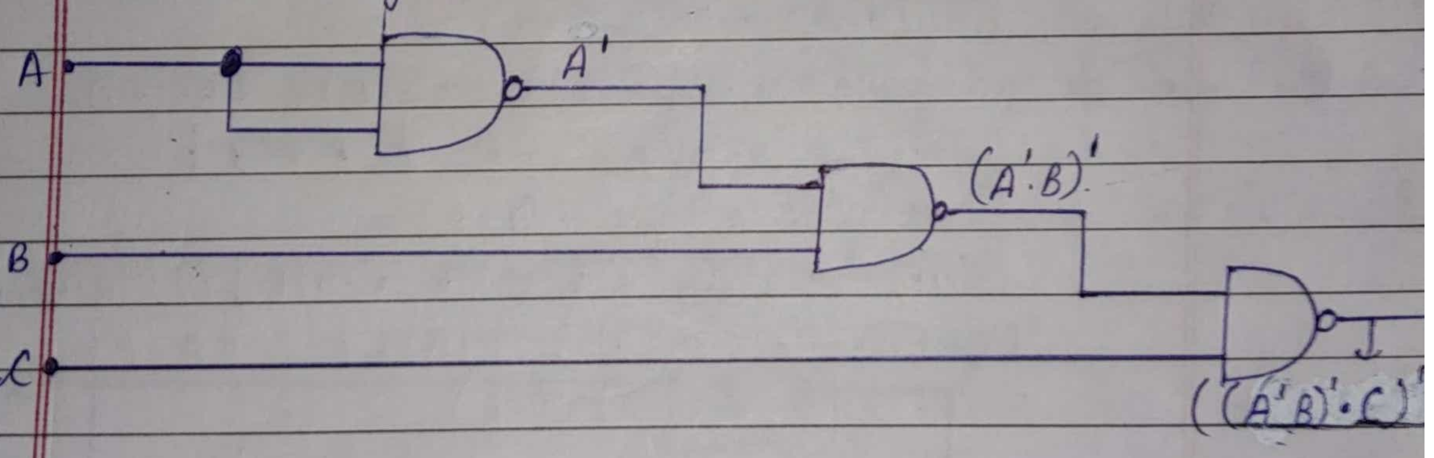
$$= C' + A'B$$

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

$$= ((A'B)' \cdot C'')' \quad \{\because \text{Using De Morgan's Law}\}.$$

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

Circuit Diagram:-



Ques-23> Implement Boolean functions.

(a) $F = (A+B')(CD+E)$ using only NAND gates.

(b) $F = A(B+CD) + BC'$ with only NOR gates.

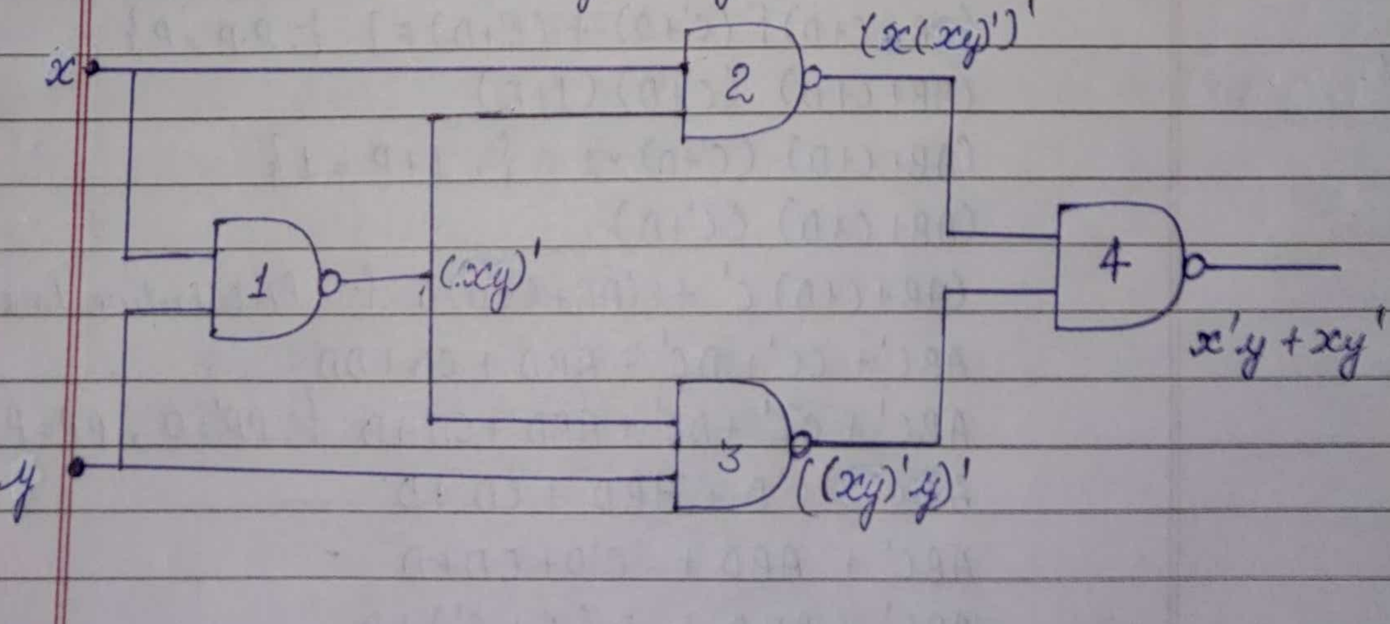
(c) $F = x'y + xy'$ using only four NAND gates.

Ans.> (a).

Date:

(c) The output from gate no. 4 is the overall output of the configuration.

$$F = ((x(xy)')'\ ((xy)'y)')'$$
$$= (x(xy)')'' + ((xy)'y)'' \quad \{\because \text{Using De Morgan}$$
$$= x(xy)' + (xy)'y$$
$$= x(x'+y') + (x'+y')y \quad \{\because \text{Using De Morgan's}$$
$$= xx' + xy' + x'y + y'y$$
$$= 0 + xy' + x'y + 0 \quad \{\because AA' = A'A = 0\}$$
$$= x'y + xy'.$$



Ques-24.> Prove that:

(a) $AB + B'C + AC = AB + B'C$.

(b) $(AB + C + D)(C' + D)(C' + D + E) = ABC' + D$.

(c) $(A+B)'(A'+B')' = 0$

Ans.> (a) To prove :- $AB + B'C + AC = AB + B'C$

Proof :- L.H.S. →

$AB + B'C + AC$

$AB + B'C + A(B+B')C$ $\{\because P+P' = 1\}$

$AB + B'C + ABC + AB'C$

$AB + ABC + B'C + AB'C$

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

$AB \times 1 + B'C \times 1$ $\{\because 1+P = 1\}$.

$AB + B'C = R.H.S.$

$\therefore$ L.H.S. = R.H.S. Hence, proved!

(b) To prove :- $(AB + C + D)(C' + D)(C' + D + E) = ABC' + D$.

Proof :- L.H.S. →

$(AB + C + D)(C' + D)(C' + D + E)$

$(AB + C + D)[((C'+D)(C'+D)) + (C'+D)E]$ $\{\because P(A+B) = PA + PB\}$

$(AB + C + D)[(C'+D) + (C'+D)E]$ $\{\because P.P = P\}$

$(AB + C + D)(C'+D)(1+E)$

$(AB + C + D)(C'+D) \times 1$ $\{\because 1+P = 1\}$

$(AB + C + D)(C'+D)$

$(AB + C + D)C' + (AB + C + D)D$ {∵ Distributive Law}

$ABC' + CC' + DC' + ABD + CD + DD$.

$ABC' + 0 + DC' + ABD + CD + D$ $\{\because PP' = 0, PP = P\}$.

$ABC' + C'D + ABD + CD + D$

$ABC' + ABD + C'D + CD + D$

$ABC' + ABD + D(C + C') + D$

$ABC' + ABD + D + D$ $\{\because P + P' = 1\}$

$ABC' + D(1 + AB) + D$

Date:

$ABC' + D + D \quad \{\because 1+P=1\}$

$ABC' + D \quad \{\because P+P=P\}$

$= R.H.S.$

$\therefore L.H.S. = R.H.S.$ Hence, Proved!

(c) To prove:- $(A+B)'(A'+B')' = 0$.

Proof:- $L.H.S. \rightarrow (A+B)'(A'+B')' = (A'.B')(A''.B'')$ {∵ Using De Morg

$= (A'.B')(AB) = A'A.B'B = 0.0 \quad \{\because P'P=0\} = 0 = R.H.S.$

$\therefore L.H.S. = R.H.S.$ Hence, Proved!

Ques-25> Using 10's complement perform $(4572)_{10} - (2102)_{10}$.

Ans.>

$$\begin{array}{r} (4572)_{10} \\ -\ (2102)_{10} \\ \hline \end{array}$$

Using 10's Complement,

$$\begin{array}{rl} (4572)_{10} & \quad 4572 \\ -\ (2102)_{10} & = +\ \text{10's complement of } 2102. \\ \hline \end{array}$$

Now, 10's complement of 2102,

$$\begin{array}{r} = 9999 \\ -2102 \\ \hline 7897 \\ +1 \\ \hline 7898 \\ \hline \end{array}$$

$$\therefore \begin{array}{r} (4572)_{10} \\ -\ (2102)_{10} \\ \hline \end{array} = \begin{array}{r} 4572 \\ +7898 \\ \hline 12470 \\ \hline \end{array}$$

Carry

Omit the carry.

$= 2470.$

Date:

Ques-26.) Multiply the $(267)_8$ and $(71)_8$ in the given base without converting to decimal.

Ans.)

$$
\begin{array}{rrrrr}
 & & 2 & 6 & 7 \\
 & \times & & 7 & 1 \\
\hline
 & & 2 & 6 & 7 \\
2 & 4 & 0 & 1 & \times \\
\hline
2 & 4 & 2 & 7 & 7
\end{array}
$$

Ques-27.) Evaluate $(103)_4 + (50)_7 = (\ )_8$.

Ans.) Solution same as the solution of ques-18.

Ques-28.) Determine the value of base b if $(211)_b = (152)_8$.

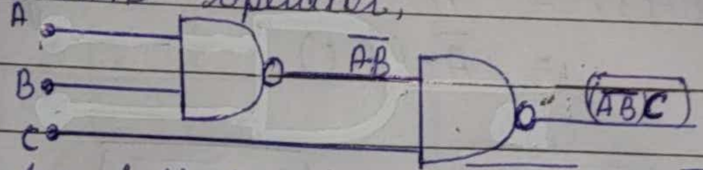
Ans.) Solution same as the solution of ques-7.

Ques-29.) Demonstrate by means of truth table the validity of the distributive law of + over ·

Ans.)

Ques.30) Show that the NOR and NAND operators are not associative.

Ans.) NAND Operator,



For Associativity, i.e. $\overline{A(\overline{BC})} = \overline{(\overline{AB})C}$.

L.H.S. →

$$\overline{(A(\overline{BC}))} = \bar{A} + \overline{\overline{BC}} \quad \{\because \text{Using De Morgan's Law}\}$$
$$= \bar{A} + BC$$

R.H.S. →

$$\overline{(\overline{AB})C)} = \overline{\overline{AB}} + \bar{C} \quad \{\because \text{Using De Morgan's Law}\}$$
$$= AB + \bar{C}$$

$$\therefore \overline{(A(\overline{BC}))} \neq \overline{(\overline{AB})C)}$$

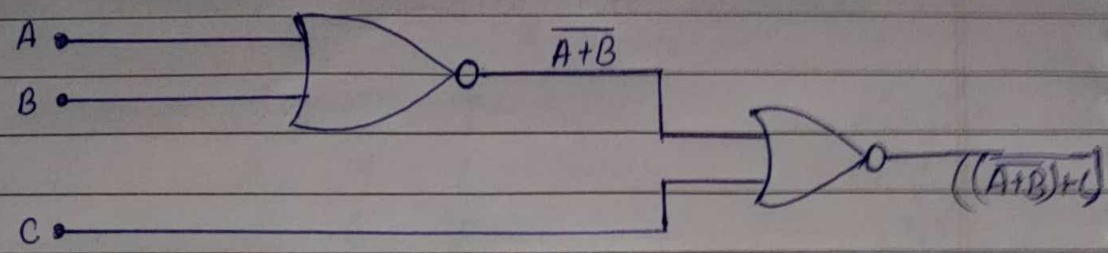
Therefore, NAND operator is not associative.

Using Truth Table,

A	B	C	AB	BC	$\overline{AB}$	$\overline{BC}$	$A(\overline{BC})$	$(\overline{AB})C$	$\overline{A(\overline{BC})}$	$\overline{(\overline{AB})C}$
T	T	T	T	T	F	F	F	F	T	T
T	T	F	T	F	F	T	T	F	F	T
T	F	T	F	F	T	T	T	T	F	F
T	F	F	F	F	T	T	T	F	F	T
F	T	T	F	T	T	F	F	T	T	F
F	T	F	F	F	T	T	F	F	T	T
F	F	T	F	F	T	T	F	T	T	F
F	F	F	F	F	T	T	F	F	T	T

From Truth Table also, the truth values of $(\overline{A(\overline{BC})})$ and $(\overline{(\overline{AB})C})$ are not equal. So, NAND operator is not associative.

NOR Operator :-



For Associativity, i.e., $(\overline{(\overline{A+B})+C}) = (\overline{A+(\overline{B+C})})$

L.H.S. →

$$(\overline{(\overline{A+B})+C}) = \overline{(\overline{A+B})} \cdot \overline{C} \quad \{\because \text{Using De Morgan's law}\}$$
$$= (A+B) \cdot \overline{C}$$

R.H.S. →

$$(\overline{A+(\overline{B+C})}) = \overline{A} \cdot \overline{(\overline{B+C})} \quad \{\because \text{Using De Morgan's law}\}$$
$$= \overline{A} \cdot (B+C).$$

$$\therefore (\overline{(\overline{A+B})+C}) \neq (\overline{A+(\overline{B+C})}).$$

Therefore, NOR operator is not associative.

Using Truth Table.

A	B	C	A+B	B+C	$\overline{A+B}$	$\overline{B+C}$	$(\overline{A+B})+C$	$A+(\overline{B+C})$	$\overline{(\overline{A+B})+C}$	$\overline{A+(\overline{B+C})}$
T	T	T	T	T	F	F	T	T	F	F
T	T	F	T	T	F	F	F	T	T	F
T	F	T	T	T	F	F	T	T	F	F
T	F	F	T	F	F	T	F	T	T	F
F	T	T	T	T	F	F	T	T	F	F
F	T	F	T	T	F	F	F	F	T	T
F	F	T	F	T	T	F	T	T	F	F
F	F	F	F	F	T	T	T	T	F	F

From truth table also, the truth values of $(\overline{(\overline{A+B})+C})$ and $(\overline{A+(\overline{B+C})})$ are not equal. So, NOR operator is not associative.