C - Commonly
O - Operating
M - Machine
P - Purposely
U - Used for
T - Technical and
E - Educational
R - Research

→ Computer was developed by Charles Babbage (Southwark, London, England). He is known as the father of the Computer. He made first analytical engine. Actually he invented difference engine in contact of a lady named Lady Ada Lovelace.

<u>Note</u> :- The full name of Lady Ada Lovelace is Augusta Ada King, Counterr of Lovelace. This lady analyses his different engine and program the analytical engine. Thus, world's first programmer is Lady Ada (London, England).

⊙ Define Computer.

<u>Ans</u> :- It is an electronic device used for storing and processing data, typically in binary form according to instructions given to it in a variable program.

* 2^8 2^7 2^6 2^5 2^4 2^3 2^2 2^1 2^0

512 256 64 32 16 8 4 2 1

⊙ Instructions :- Command
⊙ Program :- Set of instructions

Generations of Computer

* First generation of computers :- 1944 - 1958

1. ENIAC → Electronic Numerical Integralor and Calculator

It represents the first generation and was built during 1944-46. It did the followings :-

i) Used nearly 18000 vaccum tubes
ii) Used separate memory blocks for program and data
iii) It did addition, subtraction, multiplication, division and squareroot.
iv) Gave results on an electronic type writer or punch cards.
v) It used 20 electronic memory units.

- Accumulators :- Stores data for some time

2. EDVAC → Electronic Discrete Variable Automatic Computer.

It was built in 1951.

i) Used nearly 5900 vaccum tubes
ii) Stored programmed concept
iii) Used common ~~material~~ main memory block of 1024 words

- $2^{10} = 1$ kilo (1024)
  $2^{20} = 1$ Mega
  $2^{30} = 1$ Giga
  $2^{40} = 1$ Tera
  $2^{50} = 1$ Peta

iv) Used a secondary common memory of 20 K = 20×10^2 words for the program and data.
v) Reduce the extent of hardware because data was processed serially, bit by bit and numbers were stored as binary bits.
vi) Used instruction format $(\underset{\text{Used for Source address}}{A_1, A_2})$, $\overset{\text{destinatia}}{A_3}$, $\underset{\text{PC (neet instruction)}}{A_4}$, OP → (Operations)

vii) Used a separate instruction format for the input and output operations.

3. **IAS Computer** → Institute of Advance Studies, Princeton
It was built in 1951, by the modification of EDVAC.

i) Used store program concept
ii) Used a common main memory block of 4096 (4K) or 1024 (1K) words and 1 word = 40bit for the fetched instruction and data.
iii) Used concept of CPU registers so data could be accessed quickly for the instructions.
iv) Introduced accumulators (AC) register concept. The AC function as a source as well as destination operand.

$a + b = c$

operands

v) Introduce the instruction register concept. Instruction register held the instruction that have been fetched from main memory.
vi) Used program counter (PC) concept. The PC increamented after each instruction fetch to hold the next instruction address.
vii) Had a secondary memory (electromechanical device) of 16 K words.
viii) Used a magnitude core based memory for permanent storage.

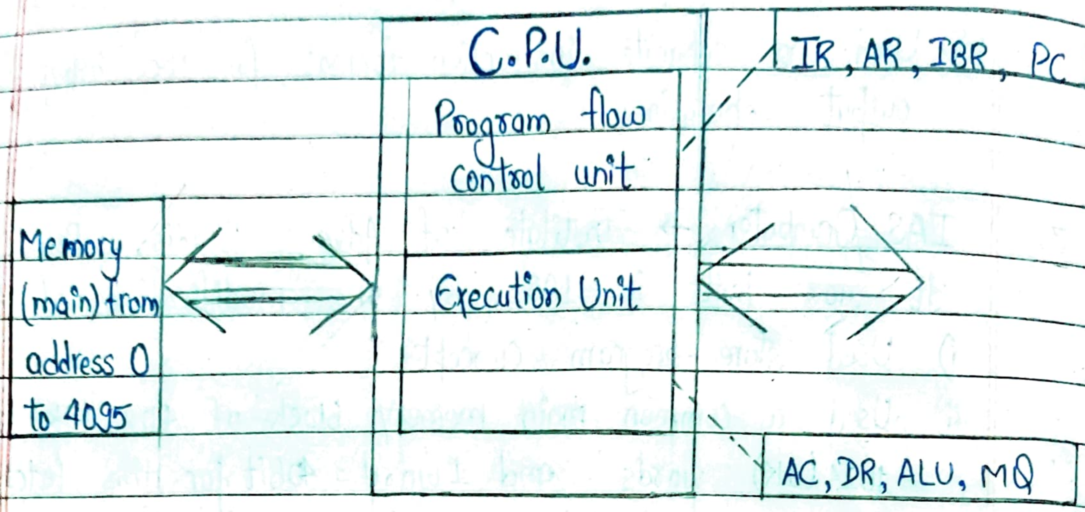


Fig. IAS Computer's Organisation

Note :- MQ – Multiplier Quotient Register
IBR – Instruction Buffer Register
AR – Accumulators Register
PC – Program Counter
DR – Data Register

ix) Hardware process the data word by word and each word was stored by of 40 bit.

x) CPU Consisted of two units :- i) Program flow control unit, and
ii) Execution Unit

Note :- 'Registers' are the fastest memory of computer, now-a-days.

* 2nd generation of computers :- 1954-68

1. Transistors were evolved for electronic circuits in 1947. These transistor circuit based computers are called 2nd generation computers. These reduced greatly the power dissipation (emission). ~~These~~ and space required in a computer. It also increased the operational speed of computations over the valved based circuits.

2. ~~ii)~~ IBM 1620 $ IBM 7094 :- They represents 2nd generation. The second generation lasted up to 1968.
It did the following :-
i) Transistors in the Computer.
ii) Ferrite cores as the main memory.
iii) Additional registers in CPU.
iv) Separate input-output processors and the disc-drive, tape-drive and line printers for input-output operations.
v) Addition and subtraction, Multiplication and division on fixed point and floating point numbers.
vi) Several addressing modes for fetching operants.
vii) Concept of stack and stack pointer for lasting first out data structure (LIFO).
viii) Concept of sub-routine call.
ix) Programming in assembly and high level languages. e.g. FORTRAN $ COBOL.

* 3rd generation of computers :- 1964 - 75

Integrated circuits were evolved for electronic circuits in 1960. These IC based computers are called 3rd generation computers. These reduced power dissipation and greatly reduced the space required for a computer. It also increased the operational speed of computations over the transistor based circuits.

The IBM 360 computers represents the 3rd generation. It introduce the following :-

i) IC's each with hundred to thousand (100 - 1000) electronic logic gates. Each IC had a large scale integration circuit (LSI).
ii) A large number of general purpose registers (GPR) of 32 bit each and 4 floating point registers of 64 bit each.
iii) Semiconductor ICs as main memory.
iv) Nearly 200 operational codes for the execution unit.
v) Enhanced number of addressing notes for fetching operands.
vi) Concept of two modes of CPU :- Super visory mode and user mode.
vii) Concept of status registers for holding the flags for exceptional conditions that result from operations or events.
viii) Concept of micro programmed implementation of instructions.
ix) Programming in assembly as well as in high level languages.
x) Software Compatibility.
xi) 32 bit instruction formats.

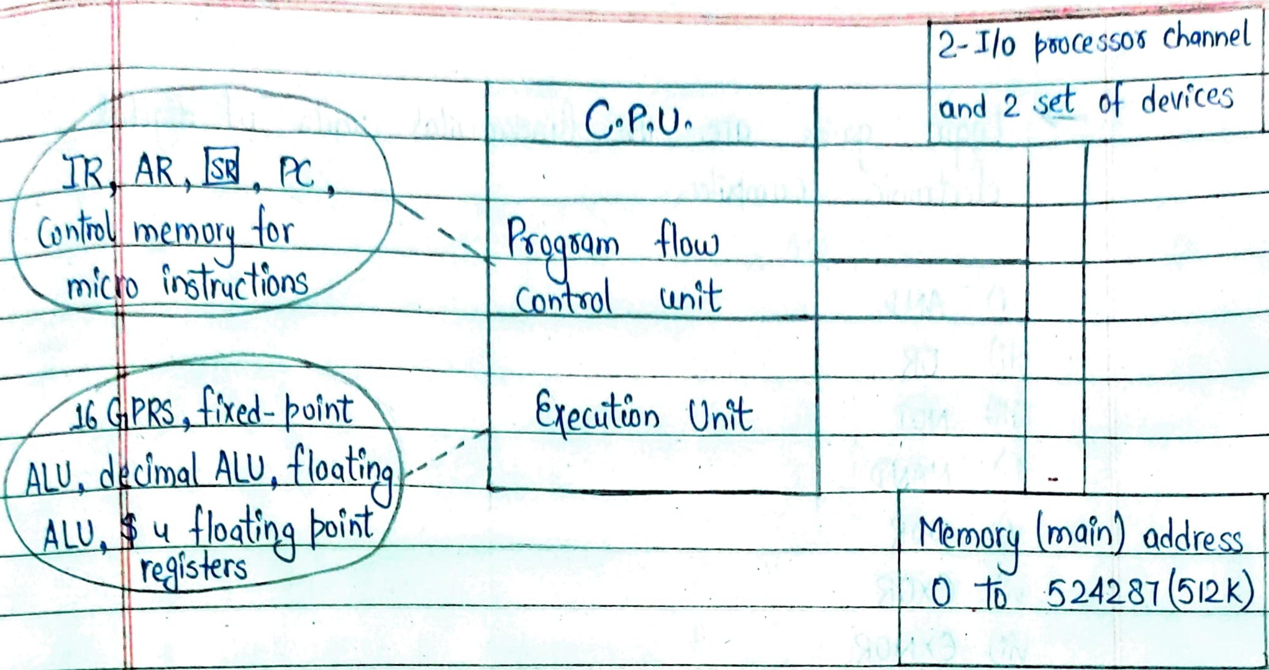


Fig. IBM 360

→ Micro programmed instruction :- An instruction executed by number of micro instructions at the execution unit which reduces the hardware complexity of execution unit of the C.P.U.

* **Logic gates** :- In digital electronics logic gates are physical device implementing a boolean function. It performs logical operation, takes one or more inputs and produce signal binary output signals.

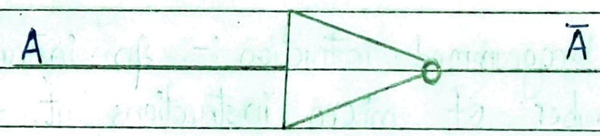
→ Logic gates are generally implemented using diode, transistors, semiconductors etc.

→ Logic gates are building blocks from which many kinds of logical circuits can be constructed.

→ Logic gates are the fundamental units of digital electronic computers.

i) AND
ii) OR
iii) NOT
iv) NAND
v) NOR
vi) EXOR
vii) EXNOR

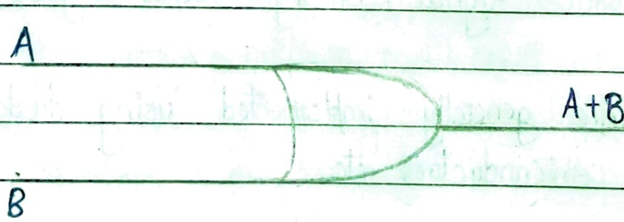
* **NOT gate** :- Single input - output



Truth table :-

A	Ā
T	F
F	T

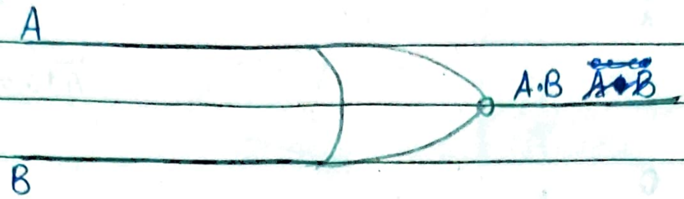
* **OR gate** :- Two input gates



Truth table :-

A	B	A+B
T	T	T
T	F	T
F	T	T
F	F	F

* AND gate :-

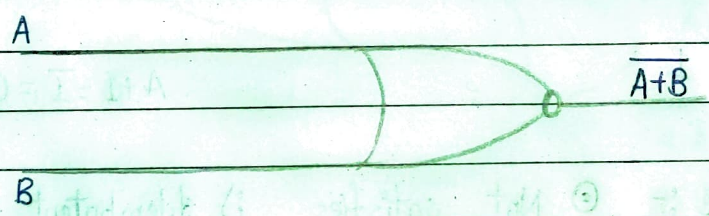


Truth table :-

A	B	~~A+B~~ A·B
T	T	~~F~~ T
T	F	F
F	T	F
F	F	F

~~Properties~~ :- ~~(a)~~ ~~A~~

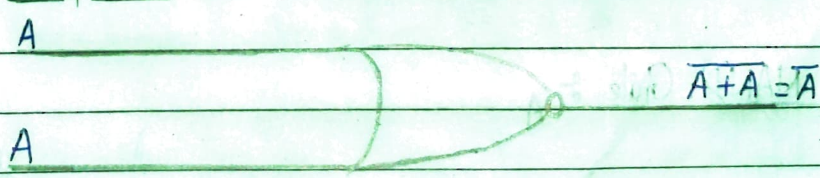
* NOR gate :- Complement of OR gate



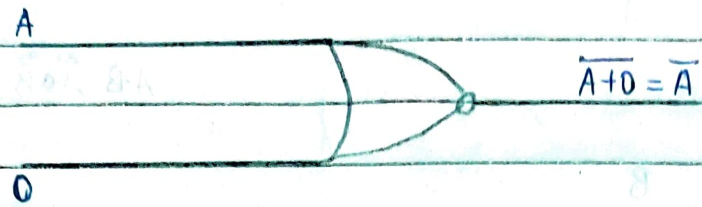
Truth table :-

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

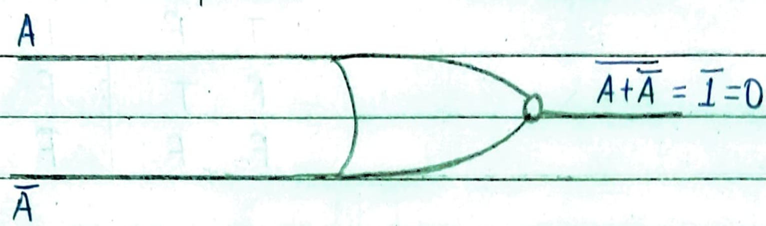
⊙ Properties :- (a) NOR with itself :- $\overline{A+A} = \overline{A}$



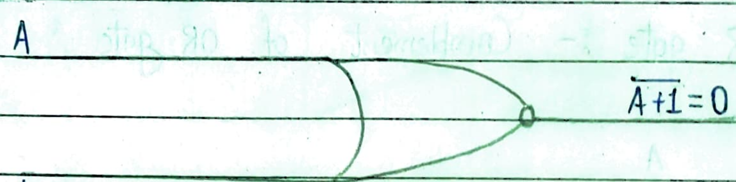
ⓑ NOR with zero :- $\overline{A+0} = \bar{A}$



ⓒ NOR with complement :- $\overline{A+\bar{A}} = \bar{1} = 0$



ⓓ NOR with one :-



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

Note :- ⊙ Not satisfies i) Idempotent law
ii) Associative law

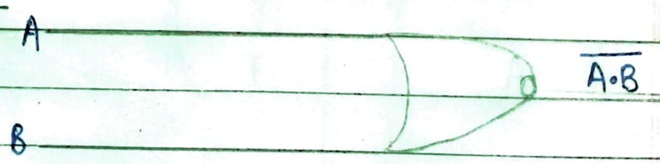
⊙ Satisfies Commutiative law

→ $\overline{a+b+c} = a + (\overline{b+c})$

→ $(\overline{a+b}) \cdot \bar{c} = \bar{a} \cdot (\overline{b+c})$

⇒ $(a+b) \cdot \bar{c} \neq \bar{a} \cdot (b+c)$

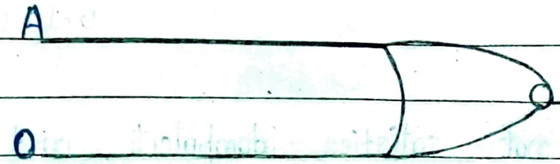
* ⦿ NAND Gate :-



Truth Table :-

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

ⓐ NAND with zero :-



$\overline{A\cdot 0} = \overline{0} = 1$

$A\cdot 0 = 0$ ←

$1\cdot 0 = 0$

$0\cdot 0 = 0$

ⓑ NAND with Complement :-

$\overline{A\cdot A} = 1$

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

$1\cdot 0 = 0$

$0\cdot 1 = 0$

ⓒ NAND with same

$\overline{A\cdot A}$

$A\cdot A = A \rightarrow \overline{A\cdot A} = \bar{A} \Rightarrow 1\cdot 1 = 1$

$0\cdot 0 = 0$

(d) NAND with one :

$A\cdot 1 = A \Rightarrow \overline{A\cdot 1} = \overline{A}$

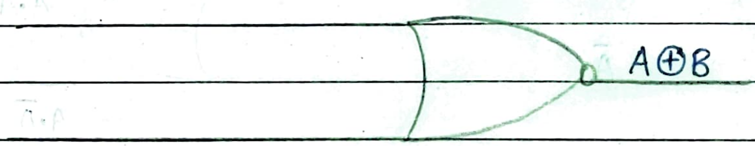
$1\cdot 1 = 1$

$0\cdot 1 = 0$

→ It does not satisfies idompotent and associative law but satisfies communitative.

* NAND and NOR are the universal gate.

* EXOR :- Exclusive OR



$A \oplus B = A\cdot B' + A'\cdot B$ (Half Adder - Sum)

Truth Table :-

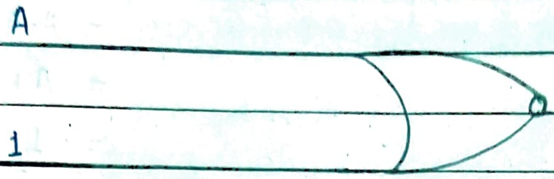
A	B	$A \oplus B$
0	0	0
0	1	0
1	0	1
1	1	0

⊙ Which of the logic gates can be worked as the cascading gates?

Ans:- EXOR

⊙ For odd no.(s) of 1, the output will be high.

1) EXOR with one

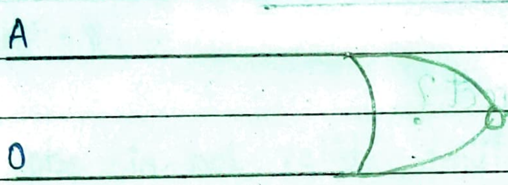


$A \oplus 1 = A\cdot 1' + A'\cdot 1$

$A\cdot 0 + A'\cdot 1 = 0 + A' = A'$

Identity law :-
i) $a+0=a$
ii) $a+1=1$
iii) $a\cdot 0=0$
iv) $a\cdot 1=a$

2) EXOR with zero



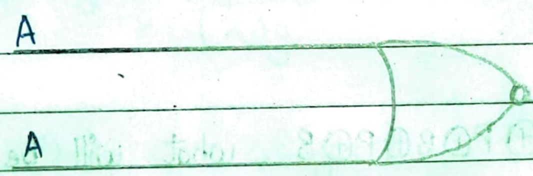
$A \oplus 0 = A\cdot 0' + A'\cdot 0$

$= A\cdot 1 + A\cdot 0$

$= A + 0$

$= A$

3) EXOR with same



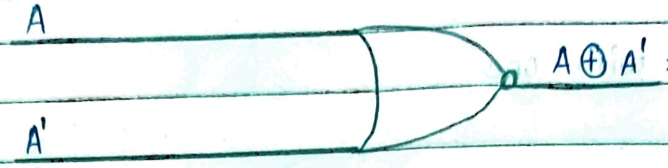
$A \oplus A = A\cdot A' + A'\cdot A$

$= 0+0$

$= 0$

⊙ If there is same complement then it will cancel out and becomes zero (in the case of AND).

4) EXOR with Complement



$$A \oplus A' = A\cdot(A')' + A'\cdot A'$$
$$= A\cdot A + A'$$
$$= A + A'$$
$$= 1$$

⊙ In the case of OR (+), the same will be 1.

→ It doesn't satisfies idempotent law but holds Commutative and associative.

Questions based on EXOR

Q.1. Which is incorrect?

a) $1 \oplus 0 = 1$

b) $1 \oplus 1 \oplus 1 = 1$

c) $1 \oplus 1 \oplus 0 = 1$

d) $1 \oplus 1 = 0$

Ans:- c) $1 \oplus 1 \oplus 0 = 1$

Q.2. $A \oplus P \oplus A \oplus P \oplus R \oplus P \oplus B \oplus P \oplus B$, what will be the output?

Ans:- $A \oplus P \oplus A \oplus P \oplus B \oplus P \oplus B \oplus P \oplus B$

$= A \oplus A \oplus P \oplus P \oplus P \oplus P \oplus B \oplus B \oplus B$

$= 0 \oplus 0 \oplus B$ ($\because$ A $ P are even, $\therefore$ $A \oplus A = 0$ and $P \oplus P \oplus P \oplus P = 0$)

$= B$ ($\because$ EXOR with zero is same).

Q.3. Let $\oplus$ denotes the EXOR. Let 1 and 0 denotes the binary constants. Consider the following expression for F over 2 variables P and Q.

$F(P,Q) = (((1 \oplus P) \oplus (P \oplus Q)) \oplus ((P \oplus Q) \oplus (Q \oplus 0)))$

a) $P+Q$

b) $(P \oplus Q)'$

c) $P \oplus Q$

d) $\cancel{P \oplus Q}\,(P+Q)'$

Ans:- $(((1 \oplus P) \oplus (P \oplus Q)) \oplus ((P \oplus Q) \oplus (Q \oplus 0)))$

$= 1 \oplus P \oplus P \oplus P \oplus Q \oplus Q \oplus Q \oplus 0$

$= 1 + (P \oplus Q \oplus 0)$

$= 1 + (P \oplus Q) \quad (\because A \oplus 1 = A')$

$= (P+Q)'$

Q.4. Which one is not valid identity?

a) $(x \oplus y) \oplus z = x \oplus (y \oplus z)$

b) $(x \oplus y) \oplus z = x \oplus (y+z)$

c) $(x \oplus y) = x+y$, if $xy = 0$

d) $x \oplus y = (xy + x'y')'$
$= (x \odot y)'$

Ans:- b) $(x \oplus y) \oplus z = x \oplus (y+z)$

Q.5. Let $x_1 \oplus x_2 \oplus x_3 \oplus x_4 = 0$, which is true?

a) $x_1 x_2 x_3 x_4 = 0$

b) $x_1 x_3 + x_2 = 0$

c) $x_1' \oplus x_3' = x_2' \oplus x_4'$

d) $x_1 + x_2 + x_3 + x_4 = 0$

Ans:- c) $x_1' \oplus x_3' = x_2' \oplus x_4'$

Q.6. If $A \oplus B = C$, then which one is invalid?

a) $A \oplus C = B$

b) $B \oplus C = A$

c) $A \oplus B \oplus C = 1$

d) $A \oplus B \oplus C = 0$

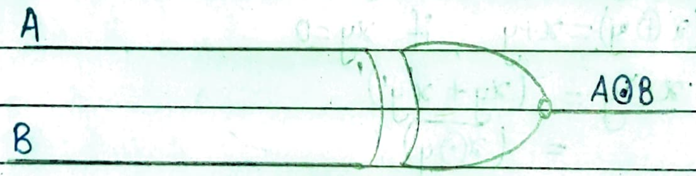
Ans:-

A	B	$A \oplus B$	$A \oplus C$	$B \oplus C$	$A \oplus B \oplus C$
0	0	0	0	0	0
0	1	1	1	0	0
1	0	1	0	1	0
1	1	0	1	1	0

* **EX-NOR :-** For a binary input EX-NOR gate output will be high if inputs are same.

OR

Output will be high (1), if number of input low (0) are even.



Truth Table :-

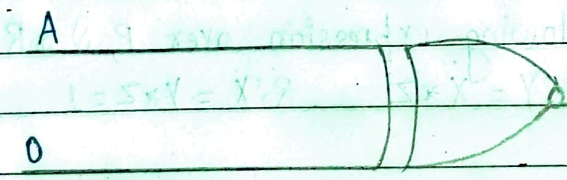
A	B	$A \odot B$
0	0	1
0	1	0
1	0	0
1	1	1

$$\boxed{A \odot B = AB + A'B'}$$

- Relation b/w EX-OR and EX-NOR :- $(EX\text{-}OR)' = (EX\text{-}NOR)$

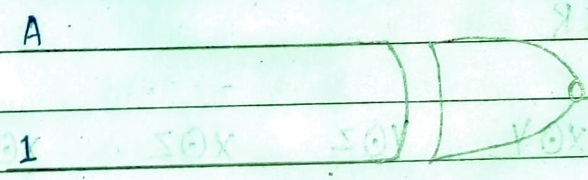
$$
\begin{aligned}
A \oplus B &= (AB' + A'B)' \\
&= (AB')' \cdot (A'B)' \\
&= (A' + B) \cdot (A + B') \\
&= A'A + A'B' + AB + BB' \\
&= 0 + A'B' + AB + 0 \\
&= AB + A'B' \\
&= A \odot B
\end{aligned}
$$

(a) EX-NOR with zero :-



$$
\begin{aligned}
A \odot 0 &= A \cdot 0 + A' \cdot 0' \\
&= A \cdot 0 + A \cdot 1 \\
&= 0 + A' \\
&= A'
\end{aligned}
$$

(b) EX-NOR with one :-

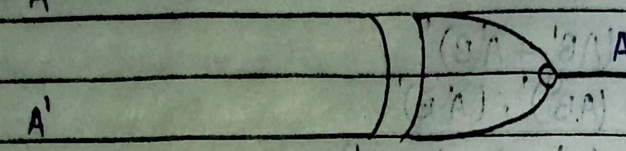


$$
\begin{aligned}
A \odot 1 &= A \cdot 1 + 1' \cdot A' \\
&= A + 0 \cdot A \\
&= A + 0 \\
&= A
\end{aligned}
$$

(c) EX-NOR with same :-

$$
\begin{aligned}
A \odot A &= A \cdot A + A' \cdot A' \\
&= A + A' \\
&= 1
\end{aligned}
$$

(d) EX-NOR with complement :-



$$A \odot A' = A \cdot A' + A' \cdot (A')'$$
$$= A \cdot A' + A' \cdot A$$
$$= 0 + 0$$
$$= 0$$

→ EX-NOR holds commutative, associative but doesn't hold idompotent law.

Q. Given $X * Y = XY + X'Y'$, Let $Z = X * Y$.
Consider the following expression over P, Q & R.
$P: X = Y * Z$, $Q: Y = X * Z$, $R: X = Y * Z = 1$

Which is true?
i) Only P & Q
ii) Only Q & R
iii) Only P & R
iv) All P, Q & R

Ans:-

X	Y	$X \odot Y$	$Y \odot Z$	$X \odot Z$	$X \odot Y \odot Z$
0	0	1	0	0	1
0	1	0	0	1	1
1	0	0	1	0	1
1	1	1	1	1	1

→ All correct → Tortology
→ All wrong → Falsifile

Q. 1) A boolean operator S is defined as follows :-
1S1 = 1, 1S0 = 0, 0S1 = 0 and 0S0 = 1 ⇒ True
What will be the truth value of the expression
$(x S y) S z = x S (y S z)$

2) (a) Which one is not correct ?
i) $(P \oplus Q)' = P \odot Q$ iii) $P' \oplus Q = P \odot Q$
ii) $P' \oplus Q = P \odot Q$ iv) $(P \oplus P') \oplus Q = (P \odot P') \odot Q'$

Ans - 1) $(x S y) S z = x S (y S z)$

Given :-

1	S	1	1
1	S	0	0
0	S	1	0
0	S	0	1

it is just as EX-NOR Truth Table
∴ $(x S y) S z = x S (y S z)$ is true because it satisfies Assosiative law.

2) The non-correct option is :-
$(P \oplus P') \oplus Q = (P \odot P') \odot Q'$

* 1975 - ownwards (VLSI ICs)

Since 1970 and VVLSI (Very very large scale integrated were evolved for the CPU's and memory.
These VLSI and VVLSI ICs based computer are called fourth generation computer.

The microprocess as a single VLSI chip CPU. Main memory chips of one MB + memory addresses were introduced as single VLSI chip. The caches were invented and placed within the microprocessor. These VLSI, VVLSI greatly reproduce and space required in a computer and the computational speed.

* IBM PC & Pentinum :- Based computer represent the forth generation. These computer introduce the following :-

(i) VLSI ICS with one lakh to 10 lakh electronic transistor and VVLSI ICS with 10 lakh + transmistor for CPU and memory.

(ii) Sing VLSI CPU chip as micro-processor.

(iii) Cache memory

(iv) large no. of register of 16 or 32 bits each with a microprocessor.

(v) A large no. of distinct instruction

vi) The concepts of pipelining and super escape in execution using for executions of instruction. Programming in assembly as well as in many high level language.

vii) Operating system and software reusable objects $ reduced.

viii) 32 bits and 64 bits fixed as well as variable length 8bits – 64 bits for instruction format.

ix) A microprocessor consisting of CPU, caches and bus interfacing units.

IR, AR, SR, PC, ID, Control memory for micro – instructions, 5 stage pipeline, dual line for super scaling	Microprocessor CPU program flow Control unit	I/O interface $ multiple device keyboard, mouse etc.
GPRs, fixed point ALU, index $ segment register	Execution Unit Cache Bus Interfacing unit.	Memory (main) address 0 to 524 – 288 (512 MB)

Number System

- Number system is an ordered sets of symbols Called digits from 0 to $r-1$, if r is the base or radix of the system.

→ There are many different number systems. In general a no. expressed in a base r system has coefficients multiplied by power of r.

$$a_n r^n + a_{n-1} r^{n-1} + \ldots + a_2 r^2 + a_1 \cdot r + a_0 + a_{-1} r^{-1} + a_{-2} r^{-2} + \ldots + a_{-m} r^{-m}$$

1) Decimal Number System :- The decimal no. system is said to be of base or radix 10, because it uses 10 digits and the coefficients are multiplied by power of 10.

2) Binary Number System :- which no. system has base 2. The coefficient of binary no. system have only 2 possible Values 0 and 1.

3) Octal Number System :- which no. system has base 8. The no. of digits in octal no. system is alway ~~one~~ less than the base. i.e. (1-7).

4) Hexa Decimal Number System :- which no. system has base 16. In a hexa decimal no. system a represents 10, b → 11, C - 12, - - - - - - - - . Its coefficients are multiplied by 16.

Conversion

i) Decimal to binary

$(81)_{10} = 2^6 \; 2^5 \; 2^4 \; 2^3 \; 2^2 \; 2^1 \; 2^0$

64 32 16 8 4 2 1

→ 1 0 1 0 0 0 1

$\therefore (81)_{10} = (1010001)_2$ Ans.

Q.2. $(27.55)_{10} = (\;)_2$

$27 = \cancel{2^5} \; 2^4 \; 2^3 \; 2^2 \; 2^1 \; 2^0$

$\cancel{32}$ 16 8 4 2 1

1 1 0 1 1

.55 = .55×2 = 1.10

= 0.10×2 = 0.20

0.20×2 = 0.40

0.40×2 = 0.80

0.80×2 = 1.60

0.60×2 = 1.20

$\therefore (27.55)_{10} = (11011.100011)_2$ Ans.

Q. $(29.625)_{10} = (\;)_2$

29 = 16 8 4 2 1

1 1 1 0 1

$(29.625) = (11101.1010)_2$ Ans.

.625×2 = 1.250

.250×2 = 0.500

.500×2 = 1.000

~~.000×2 = 0~~

Q. $(1247.78)_{10} = (\ )_2$

1247 / 1024	512	256	128	64	32	16	8	4	2	1
1	0	0	1	1	0	1	1	1	1	1

$\therefore (10011011111.1100)_2$

$.78 \times 2 = 1.56$
$.56 \times 2 = 1.12$
$.12 \times 2 = 0.24$
$.24 \times 2 = 0.48$

ii) Decimal to octal

Q. $(41)_{10} = (\ )_8$

8	41	1
	5	

$= (51)_8$ Ans.

Q. $(3476)_{10} = (\ )_8$

8	3476	4
8	434	2
8	54	6
	6	

$= (6624)_8$

Q. $(1011.27)_{10} = (\ )_8$

8	1011	3
8	126	6
8	15	7
	1	

$(1763)_8$

$\therefore (1011.27)_{10} = (1763.2121)_8$

$.27 \times 8 = 2.16$
$.16 \times 8 = 1.28$
$.28 \times 8 = 2.24$
$.24 \times 8 = 1.92$

512
×2
1024
×2
2048

1024
512
1536

1247
1141
106

iii) Decimal to Hexa decimal.

Q. $(1247.78)_{10} = ()_{16}$

Q. $(243)_{10} = ()_{16}$

Q.2.

16	243	3
	15	

$\Rightarrow (243)_{10} = (15\,3)_{16} = (F3)_{16}$

16	1247	15
16	77	13
	4	

$\Rightarrow (4\ 13\ 15)_{16} = (4df)_{16}$.

$\cancel{\Rightarrow (1247)_{10} = (13\,4\,15)_{16} = (C4e)_{16}}$

$\cancel{(12\ 7\ 10)_{16} = (47a)_{16}}$

$.78 \times 16 = 12.48$

$.48 \times 16 = 7.68$

$.68 \times 16 = 10.88$

$.88$

$\Rightarrow (12\ 7\ 10)_{16} = (C7)_{16}$.

$\therefore (1247.78)_{10} = (4df.C7)_{16}$

* Binary to Decimal

$(10000111)_2 = (\ )_{10}$

$1\times2^7+0\times2^6+0\times2^5+0\times2^4+0\times2^3+1\times2^2+1\times2^1+1\times2^0$

$= 128+0+0+0+0+4+2+1$

$= (135)_{10}$

Or

256	128	64	32	16	8	4	2	1
	1	0	0	0	0	1	1	1

$= 128+4+2+1$

$= (135)_{10}$

Q.1 $(11101101)_2 = (\ )_{10}$

128	64	32	16	8	4	2	1
1	1	1	0	1	1	0	1

$= 128+64+32+8+4+1$

$= (237)_{10}$

13
32
45
64
109
128
237

Q.2 $(101.11)_2 = (\ )_{10}$

101 =

4	2	1
1	0	1

$= 4+1$

$= 5$

~~$2\ 1$~~
~~$1\ 1$~~
~~$= 1+1$~~
~~$= 2$~~

$\therefore 101 = 5.$

$.11 = .1\times2^{-1} + 1\times2^{-2}$

$= \frac{1}{2} + \frac{1}{4}$

$= \frac{2+1}{4} = \frac{3}{4}$

$\therefore (101.11)_2 = (5.75)_{10}$

Q.3. $(101110.10101)_2 = (\ )_{10}$

32	16	8	4	2	1
1	0	1	1	1	0

$= 32+8+4+2$

$= 46$

$10101 = 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3} + 0\times2^{-4} + 1\times2^{-5}$

$= \frac{1}{2} + \frac{1}{4}0 + \frac{1}{8} + 0 + \frac{1}{32}$

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

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

$= \frac{21}{32}$

$= 0.65$

$\therefore (101110.10101)_2 = (46.65)_{10}$ Ans.

* Binary to Octal

$(101)_2 = (\ )_8 \Rightarrow \underline{8 = 2^3}$

$$\begin{array}{ccc} 1 & 0 & 1 \\ 4 & 2 & 1 \end{array}$$

$= 4 + 1$

$= (5)_8$

Q. $(010\ 111\ 110\ 111\ 0101)_2$

$= (27675)_8$ Ans.

Q. $(1101)_2 = (\ )_{10} = (\ )_8$

$(1101)_2 =$

$$\begin{array}{cccc} 8 & 4 & 2 & 1 \\ 1 & 1 & 0 & 1 \end{array}$$

$= 8 + 4 + 1$

$= (13)_{10}$

$(13)_{10} = (\ )_8$

$$\begin{array}{c|c|c} 8 & 13 & 5 \\ & 1 & \end{array}$$

$= (15)_8$ Ans.

Q. $(11101.11101)_2 = (\ )_8$

$\underbrace{011}\underbrace{101}.\underbrace{111}\underbrace{010}$

3 5 . 7 2

$\therefore (11101.11101)_2 = (35.72)_8$ Ans.

* Binary to hexadecimal :-

Q. $(11111011)_2 = (\ )_{16}$

$(11111011)_2 =$ 128 64 32 16 8 4 2 1

1 1 1 1 1 0 1 1

$= 128+64+32+16+8+2+1$

$= 251$

16	251	11
	15	

$\therefore (251)_{16} = (15\ 11)_{16}$

$= (FB)_{16}$ Ans.

Q. $(101011101)_2 = (\ )_{16}$

$\underbrace{0001}\underbrace{0101}\underbrace{1101}$

1 5 13 $= (15D)_{16}$ Ans.

= ~~[illegible] Ans.~~

Q. $(111011100.101101011)_2 = (\ )_{16}$

$\underbrace{1}\underbrace{1101}\underbrace{1100}$

$= (1\ 13\ 12)_{16}$

$= (1 d c)_{16}$

$\underbrace{1011}\underbrace{0110}\underbrace{1100}$

$= 11\ 6\ 12$

$= (\cancel{a5b})_{16} = (b6c)_{16}$

$\therefore (111011100.101101011)_2 = (1DC.B6C)_{16}$ Ans.

* Octal to binary

Q. $(673)_8 = (\ )_2$

6 7 3
110 111 011

$= (110111011)_2$ Ans.

Q. $(547.124)_8 = (\ )_2$

5 4 7 . 1 2 4
101 100 111 001 010 100

$= (101100111.001010100)_2$ Ans.

* Octal to decimal

Q. $(75)_8 = (\ )_{10}$

$7\times8^1 + 5\times8^0$
$= 56+5$
$= (61)_{10}$

Q. $(101.1)_8 = (\ )_{10}$

$101.1 = 1\times8^2 + 0\times8^1 + 1\times8^0 . 1\times8^{-1}$
$= 64+1 . 1\times\frac{1}{8}$
$= 65.\frac{1}{8}$
$= 65+0.125$
$= (65.125)_{10}$ Ans.

* Octal to hexadecimal

Q. $(774)_8 = (\ )_{16}$

$7\times8^2 + 7\times8^1 + 4\times8^0 = 448+56+4 = (508)_{10}$

$(508)_{10} = (\ )_{16}$

16	508	12
16	31	15
	1	

$\therefore (508)_{10} = (1\ 15\ 12)_{16}$
$(1\ F\ C)_{16}$ Ans.

or

7 7 4

111 111 100

$\underbrace{000}\underbrace{1111}\underbrace{1100}$

$= 1\ 15\ 12$

$= (1FC)_{16}$ Ans.

Q. $(453.765)_8 = (\ )_{16}$

4 5 . 3 7 6 5

100 101 011 111 110 101

$0001\underbrace{0010}\underbrace{1011} . \underbrace{1111}\underbrace{1010}1000$

1 2 11 15 10 8

1 2 B F A 8

$\therefore (453.765)_8 = (12B.FA8)_{16}$ Ans.

Q. $(1213.4356)_8 = (\ )_{16}$

1 2 1 3 . 4 3 5 6

0001 0010 0001 0011 100 011 101 110

$\underbrace{0010}\underbrace{1000}\underbrace{1011} . \underbrace{1000}\underbrace{1110}\underbrace{1110}$

2 8 11 8 14 14

$= (28B.8EE)$ Ans.

* Hexa to binary

$(FF)_{16} = (\ )_2$

F F

1111 1111

$= (11111111)_2$ Ans.

Q. $(A6B)_{16} = (\ )_2$

A 6 B

1010 0111 1011

$= (101001111011)_2$ Ans.

Q. $(FDA.A9C)_{16} = (\ )_2$

F D A . A 9 C

1111 1101 1010 1010 1001 1100

$(111111011010.101010011100)_2$ Ans.

* Hexa to Decimal

$(A9)_{16} = (\ )_{10}$

A 9

$10 \times 16^1 + 9 \times 16^0$

$= 160 + 9$

$= (169)_{10}$ Ans.

Q. $(DE5)_{16} = ()_{10}$

D E 5

$13\times16^2 + 14\times16^1 + 5\times16^0$

$= 3328 + 224 + 5$

$= (3553)_{10}$ Ans.

Q. $(AFC.39A)_{16} = ()_{10}$

$$\boxed{\begin{array}{cccccc} A & F & C \,. & 3 & 9 & A \\ 1010 & 1111 & 1100 & 011 & 101 & 1010 \\ \multicolumn{6}{l}{= (101011111100.0111011010)_2} \end{array}}$$

$10\times16^2 + 15\times16^1 + 12\times16^0 . 3\times16^{-1} + 9\times16^{-2} + 10\times16^{-3}$

$= (2812.224)_{10}$

* Hexa to Octal

Q. $(A9)_{16} = ()_8$

A 9

1010 1001

$= (10101001)_8$ Ans.

Q. $(AFC.39A)_{16} = ()_8$

A F C . 3 9 A

1010 1111 1100 . 0011 1001 1010

$= (101011111100.001110011010)_2$

$= (5374.1632)_8$ Ans.

* Any to Any

Q. $(23)_4 = (\ )_7$

$2\times4^1+3\times4^0$
$= 8+3$
$= 11$

7	11	4
	1	

$= (14)_7$ Ans.

Q. $(354)_6 = (\ )_3$

$3\times6^2+5\times6^1+4\times6^0$
$= 108+30+4$
$= 142$

3	142	1
3	47	2
3	15	0
3	5	2
	1	

$\therefore (354)_6 = (12021)_3$ Ans.

Q. $(43)_x = (y3)_8$ How many different solutions for x and y.

Ans:- Here, $x > 4$ and $y < 8$

$\therefore 4 \times x^1 + 3 \times x^0 = y \times 8^1 + 3 \times 8^0$

$\Rightarrow 4x + \cancel{3} = 8y + \cancel{3}$

$\Rightarrow \cancel{4}x = \overset{2}{\cancel{8}}y$

$\Rightarrow x = 2y$

x	y
8	4
10	5
12	6
14	7

Q. $(123)_5 = (x8)_y$, find no. of combinations for x and y.

Ans:- $x < y$, $y > 8$

$1 \times 5^2 + 2 \times 5^1 + 3 \times 5^0 = x \times y^1 + 8 \times y^0$

$\Rightarrow 25 + 5 + 3 = xy + 8$

$\Rightarrow 38 - 8 = xy$

$\Rightarrow 30 = xy$

x	y
1	30
2	15
3	10

Q. $\dfrac{(312)_x}{(20)_x} = (13.1)_x$ not in decimal system. Find the base(x).

Ans: $3\times x^2 + 1\times x^1 + 2\times x^0 = 1\times x^1 + 3\times x^0 \cdot 1\times x^{-1}$

$\Rightarrow 3x^2 + x + 2 = x + 3 + \dfrac{1}{x}$

$\Rightarrow 3x^2 + \cancel{x} - \cancel{x} + 2 - 3 = \dfrac{1}{x}$

$\Rightarrow 3x^3 - x = 1$

Q. $\dfrac{(312)_x}{(20)_x} = (13.1)_x$, not in decimal system. Find the base(x).

Ans: $\dfrac{3\times x^2 + 1\times x^1 + 2\times x^0}{2\times x} = 1\times x^1 + 3\times x^0 \cdot 1\times x^{-1}$

$\Rightarrow \dfrac{3x^2 + x + 2}{2x} = x + 3 + \dfrac{1}{x}$

$\Rightarrow \dfrac{3x^2 + x + 2}{2\cancel{x}} = \dfrac{x^2 + 3x + 1}{\cancel{x}}$

$\Rightarrow 3x^2 + x + 2 = 2x^2 + 6x + 2$

$\Rightarrow 3x^2 - 2x^2 + x - 6x + 2 - 2 = 0$

$\Rightarrow x^2 - 5x = 0$

$\Rightarrow x(x-5) = 0$

$\Rightarrow x = 0$ or $x = 5$

$\because x = 0$ is not possible. ~~bcz x~~

$\therefore x = 5$ **Ans.**

Hence, base is 5.

Q. $x^2-12x+37=0$, decimal roots are 8 and 5, find base.

Ans:

Q. $(73)_x = (54)_y$

Ans: $x>7$, $y>5$

$7\times x^1 + 3\times x^0 = 5\times y^1 + 4\times y^0$

$\Rightarrow 7x+3 = 5y+4$

$\Rightarrow 7x = 5y+1$

$\Rightarrow 7x-5y=1$

x	y
8	11

Q. $\sqrt{(224)_x} = 13$, base is:

a) 10

b) 8

c) 5

d) 6

Ans: $\sqrt{(224)_x} = (13)_x$ (Assume)

$\Rightarrow \sqrt{2\times x^2 + 2\times x^1 + 4\times x^0} = 1\times x^1 + 3\times x^0$

$\Rightarrow 2x^2 + 2x + 4 = (x+3)^2$

$\Rightarrow 2x^2 + 2x + 4 = x^2 + 6x + 9$

$\Rightarrow 2x^2 - x^2 + 2x - 6x + 4 - 9 = 0$

$\Rightarrow x^2 - 4x - 5 = 0$

$\Rightarrow x^2 - 5x + x - 5 = 0$

$\Rightarrow x(x-5) + (x-5) = 0$

$\Rightarrow (x-5) = 0$

$\therefore x = 5$ Ans.

Hence, the base is 5.

* In base r, with n digit, no. ranges from 0 to $r^n - 1$.

$\therefore$ (number) $\leq r^n - 1$

$\Rightarrow$ number $+ 1 \leq r^n$

$\Rightarrow \log_r(\text{number}+1) \leq \log_r(r^n)$

$\Rightarrow \boxed{\log_r(\text{number}+1) \leq n}$

Q. $(1745)_{10}$, find no. of bits required to represent given number.

Sol^n: $\log_2(1745+1) \leq n$

$2^{10} = 1024$

$2^{11} = 2048$

$\therefore$ No. of bits $= 11$ Ans.

Q. $(74256)_{10} = (\xleftrightarrow{n})_4$

$\log_4 (74256+1) \le n$

$\Rightarrow \log_4 (74257) \le n$

$= \frac{4.87}{\log 4} = \frac{4.87}{0.627} = 8.09 \approx 9$ Ans.

Hence, no. of digits are 9.

* Signed and Unsigned no.

→ Unsigned numbers :- Number without any positive or negative sign. It can be considered as positive.

⊙ For n bits, unsigned number ranges from 0 to $2^n - 1$.

Character :- 8 bit $= 2^8$
$= 0$ to $2^8 - 1$
$= 0$ to 255