## Paper 7, TDC Part-3

Chapter- 3, Number Systems and Codes Electronics
Lecture - Binary Addition

> By:

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## Number Systems and Codes

- Binary Arithmetic :-

We perform different types of arithmetic calculation using digital systems like calculator, computer etc. We are also familiar with the things that the data we provide to digital system i.e. inputs, are first converted to binary number then it is handle by the digital system for necessary operation.
Arithmetic operation such as addition, subtraction, multiplication and division is performed to binary numbers in digital systems.

## Number Systems and Codes

- Binary Addition : -

As any number in binary number system is expressed as series combination of $0 \& 1$, in similar manner the result of addition of two and more numbers in binary system is a series combination of 0 \& 1. Therefore the four basic rules for adding 0 \& 1 are: -

$$
\begin{array}{ll}
0+0=0 & ----- \text { Sum part is } 0 \text { and carry part is } 0 . \\
0+1=1 & ---- \text { Sum part is } 1 \text { and carry part is } 0 . \\
1+0=1 & ---- \text { Sum part is } 1 \text { and carry part is } 0 . \\
1+1=1 & 0--- \text { Sum part is } 0 \text { and carry part is } 1 .
\end{array}
$$

## Number Systems and Codes

In the fourth rule we se that addition of two 1's results in binary two $(10)_{2}$. When binary numbers are added, the last condition results a sum of ' 0 ' in a given column and generate a carry of 1 over to the next column to the left. Let's see few examples.

Examples- Add the following binary numbers -
a) 11001 and 1000
b) 11100 and 11010
c) 10110101 and 11100011

Number Systems and Codes
(i) Add the billowing binary numbers:-
(ii) (11180) and (10i0)
(iii) $(101101001)_{2}$ and $\left.\begin{array}{llllll}101 & 1 & 1 & 0 & 0 & 0 \\ 1 & 1\end{array}\right)$ e

Solution:-(a) $\quad \square$ carry from previous
As $1+1=01$
So the generated carry trams is added to the next higher binary bot
So. Insurer is (100001) 2
Lets verify this, using decimal number

$$
\begin{aligned}
& (110001)_{2}=(25) 10 \\
& +(1000)_{2}=+(8) 10 \\
& (100001)_{2}=(33)_{10}
\end{aligned}
$$



$$
\begin{aligned}
1_{2}+1_{2} & =(10)_{2}=(2)_{10} \\
1_{2}+1_{2}+1_{2} & =(10)_{2}+(1)_{2} \\
& =(111)_{2}=(3)_{10}
\end{aligned}
$$

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Number Systems and Codes
So answer is $(110110)_{2}$
Let again verity this using dacimal system.

$$
\begin{aligned}
& \left(\begin{array}{lllll}
1 & 1 & 1 & 0 & 0
\end{array}\right)_{2} \\
& +\left(\begin{array}{llll}
1 & 1 & 0 & 0
\end{array}\right)=\left(\begin{array}{ll}
2 & 8 \\
2 & 6
\end{array}\right) 10 \\
& 5
\end{aligned} 1010
$$

(c)

$$
\begin{array}{llllll}
\begin{array}{llll}
1 & 1 & 1 & 1 \\
1 & 0 & 1 & 1 \\
1 & 1 & 1 & 0 \\
1 & 0 & 0 & 1 \\
1 & 0 & 0 & 1
\end{array} 1 & 0 & 1 & 1 & \text { Carry } \\
\hline 1 & 0 & 1_{2}+1_{2}+1_{2}=\left(\begin{array}{ll}
1 & 1
\end{array}\right)_{2} \\
\hline 1 & 1_{2}+1_{2}+0_{2}=\left(\begin{array}{ll}
1 & 0
\end{array}\right)_{2}
\end{array}
$$

So answerer is $(110011000)_{2}=$ Let verify this also using decimal system

$$
\begin{aligned}
& (10110101)_{2}=(10011)_{2}=(2127) 10 \\
& \frac{(110}{(11001010}=(10) 10
\end{aligned}
$$

Number Systems and Codes
Example (2) held the binary numbers as given (i) $(1100111)=(10100)_{2}$ \& $(10001)_{2}$
(ii) $\left(\begin{array}{llll}1 & 0110 \\ (100 & 1 & 0 & 1 f_{2} \\ (100 \$ 11)_{2},(001001)_{2} \&\end{array}\right.$

Soln- We can add 2 or more binary numbers in
two ways. two ways.
Lat Method:-

1) Take pst two numbers, and add it. tate, Add tho third number to the ream obtained by If It adding the fid two numb ers. Again add the surexions sum obtained and so om.
2) Ind method $A \rightarrow$ all given numbers at a time. $^{\text {nd }}$ ald
(a) Addition of numbers given above in $(i)$ by tat method.

$$
\begin{aligned}
& \text { (1) } \left.\begin{array}{ccccc}
1 & 1 & 0 & 1 & 1
\end{array}\right)_{2}^{2} \\
& +\left(\begin{array}{llll}
1 & 0 & 1 & 0 \\
1 & 1 & 1 & 1
\end{array}\right. \\
& \left(\begin{array}{lll}
1 & 1
\end{array}\right)_{2}
\end{aligned} \quad \text { Sum of } 1^{\text {st }} \text { two }
$$

Number Systems and Codes
Now adding, $3^{\text {rd }}$ numbing to the sum,

Students can remity the reanlt in decimal system
स Now, addition of number given in $(i)$ through second method.

Carry generated from $\begin{array}{llllll}\text { 1 } & 1 & 1 & 1 & \text { Marry generated } \\ 1 & 1 & 0 & 1 & 1 & \leftarrow \\ 1 & 0 & 1 & 0 & 0 & \leftarrow\end{array}$

$$
\left.\begin{array}{rllll}
1 & 0 & 1 & 0 & 0 \\
1 & 1 & 0 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 \\
1 & 0
\end{array}\right)
$$

5) Adolitim of give numbers given in (ii) thenosi 0 ind method

Number Systems and Codes

$$
\begin{aligned}
& \left.\begin{array}{cccccccc}
1 \\
1 & 1 & 0 & 1 & 0 & 1 & 0 & \leftarrow \\
+ & 1 & 0 & 0 & 1 & 0 & 1 \\
1 & 0 & 0 & 0 & 1 & 1 & 1 & 1
\end{array}\right)=\text { Sum } \quad \text { Fourth Number }
\end{aligned}
$$

Students can verify the rexult in decimal
system. system.

* Now, addition of numbers given in (ii)
through second method?

$$
\begin{aligned}
& \left(\begin{array}{lllll}
1 & 1 & 10 & 1 & 1
\end{array}\right) \quad \text { Carry } \\
& \begin{array}{cccccccc}
1 & 1 & 0 & 1 & 1 & 0 & \leftarrow & 1 \text { int Number } \\
1 & 0 & 0 & 1 & 1 & 1 & \leftarrow & 2^{n d} \\
0 & 0 & 1 & 1 & 0 & 1 & \leftarrow & 3^{\gamma d}
\end{array}
\end{aligned}
$$

## Number Systems and Codes

From the examples it can observed that,
i) If the number of 1 's to be added in a column is even then the sum bit is ' 0 ', and if the number of 1 's to be added in a column is odd then the sum bit is ' 0 '.

## Thank You

