Digital Electronics Introduction

Presented by Nabanita Das

What is Digital Electronics ?

- Digital Electronics is that branch of electronics which deals with the digital signals to perform various tasks and meet various requirements !
- It is based upon the digital design methodologies and consists of digital circuits, IC’s and logic gates.
- It uses only binary digits, i.e. either ‘0’ or ‘1’ !

Why was digital electronics needed?

- Most analog systems were less accurate, and were slow in computation and performance.
- Digital system have the ability to work faster than analog equivalents, and can operate on very high frequencies too.
- It was much economical than analog methodologies as the performance was faster !

(Analog Vs Digital) Electronics

Analog Electronics

- It has usually large circuits & occupies more area.
- Analog measuring instruments are less accurate, and the chances of misreading are more.
- The instruments are delicate and harms are more in case of drops and falls.

Digital Electronics

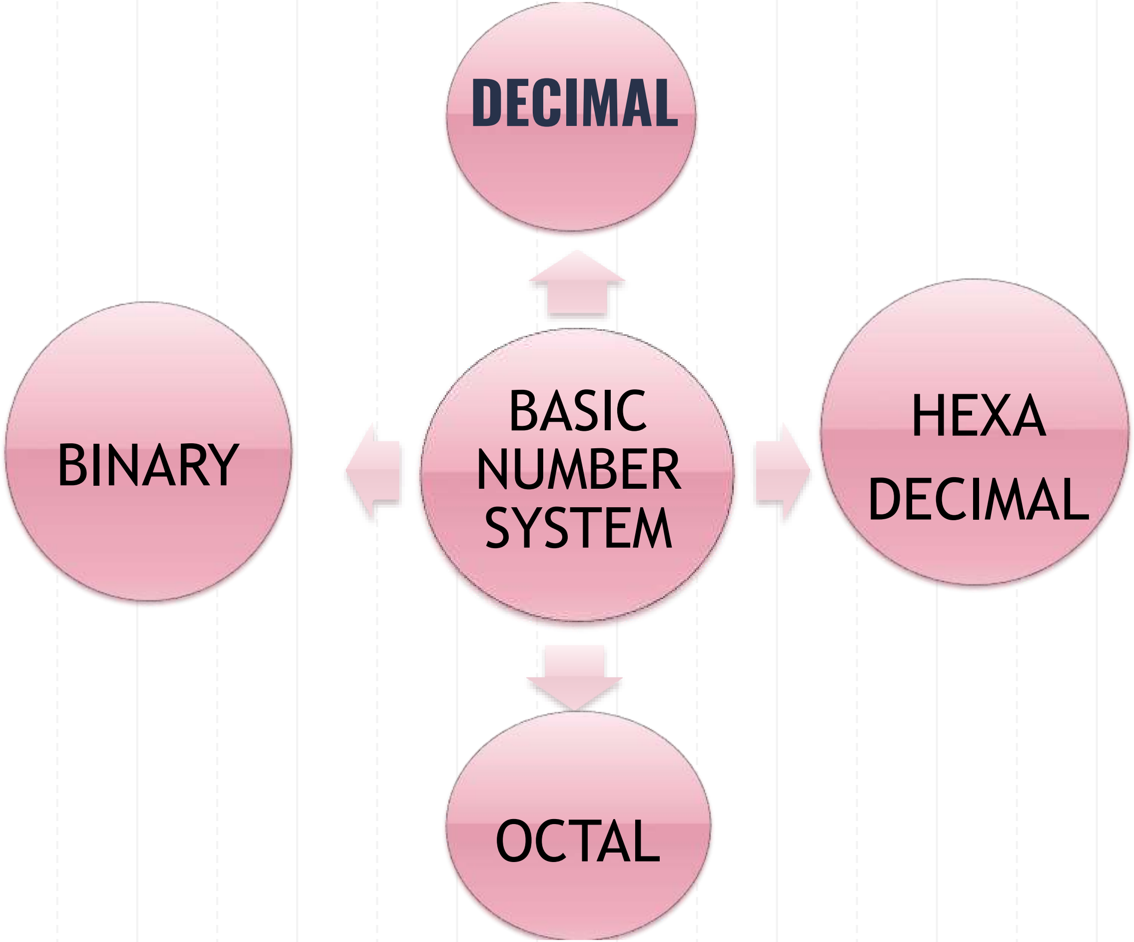
- It has smaller integrated circuits & occupies lesser area.
- Digital measuring instruments are more accurate, and there is no case of misreading it.
- The instruments are more strong, and there are lesser harms on drops and falls.

Example of Advantage of Digital Systems over Analog Systems

- The most common present time example is the speedometers used in vehicles.
- In analog meters, there is an error chance of misreading the speed, while in the digital seven-segment display of a digital speedometer, there is no chances left for a misreading error, hence increasing the accuracy !
- Even in the digital meters, there is a ‘HOLD’ button to hold the display value on screen.

HOW THE COMPUTER GETS THE ANSWER

$$\begin{array}{r} 2 \\ \underline{+1} \\ =3 \end{array}$$


DECIMAL
BINARY
BASIC NUMBER SYSTEM
HEXA DECIMAL
OCTAL

DECIMAL NUMBER SYSTEM

DIGITS	• 0,1,2,3,4,5,6,7,8,9.
BASE	• 10

DECIMAL NUMBER 4598

$8*10^{0}$

$9*10^{1}$

$5*10^{2}$

$4*10^{3}$

BINARY NUMBER SYSTEM

DIGITS	0,1
BASE	2

BINARY NUMBER 1011

$1*2^3$

$0*2^2$

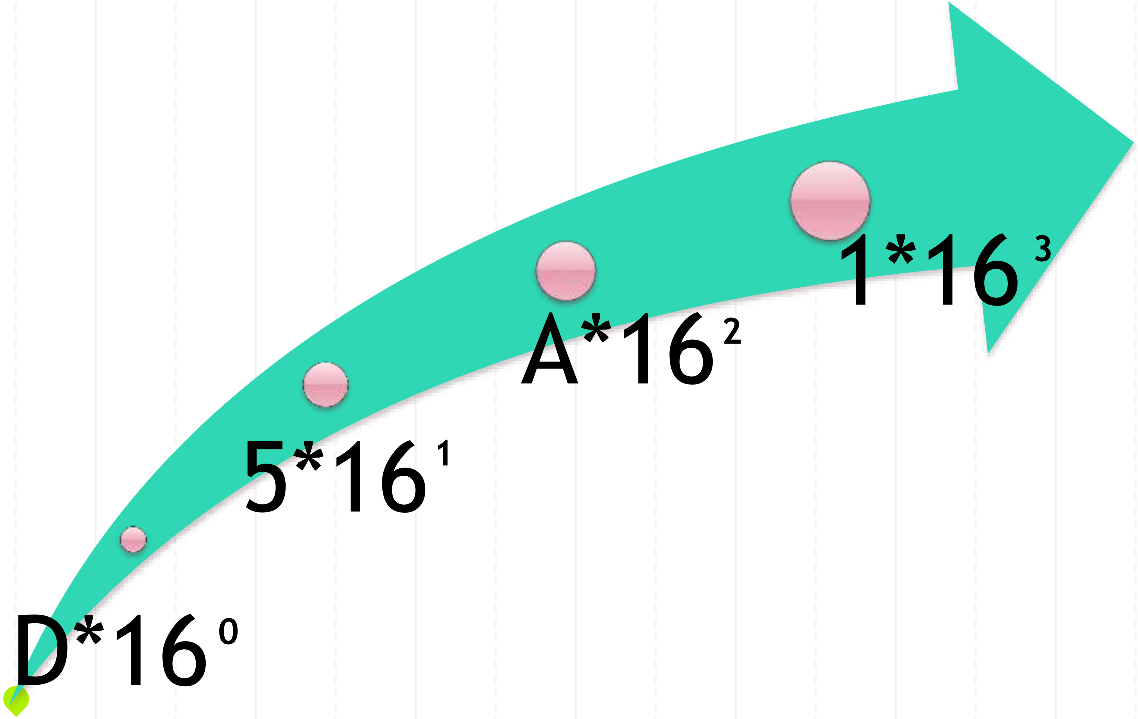
$1*2^1$

$1*2^0$

HEXADECIMAL NUMBER SYSTEM

DIGITS	• 0,1,2,3,4,5,6,7, • 8,9,A,B,C,D,E,F.
BASE	• 16

HEXADECIMAL NUMBER 1A5D



OCTAL NUMBER SYSTEM

DIGITS	• 0,1,2,3,4, • 5,6,7.
BASE	• 8

OCTAL NUMBER 5273

$3*8^0$

$7*8^1$

$2*8^2$

$5*8^3$

BINARY TO DECIMAL

BINARY

- 1 0 1 0 1

BIT POSITION

- 5 4 3 2 1

MUL WITH BASE

- $1*2^4+0*2^3+1*2^2+0*2^1+1*2^0$.

DECIMAL

- 21_{10}

ANOTHER EXAMPLE OF BINARY TO DECIMAL

Convert binary number of: 1101.0111_2, into its decimal number equivalent.

$$1101.0111 = (1\times2^{3}) + (1\times2^{2}) + (0\times2^{1}) + (1\times2^{0}) + (0\times2^{-1}) + (1\times2^{-2}) + (1\times2^{-3}) + (1\times2^{-4})$$

$$= 8 + 4 + 0 + 1 + 0 + 1/4 + 1/8 + 1/16$$

$$= 8 + 4 + 0 + 1 + 0 + 0.25 + 0.125 + 0.0625 = 13.4375_{10}$$

Hence the decimal equivalent number of 1101.0111_2 is given as: 13.4375_{10}

HEXADECIMAL TO DECIMAL

HEX

- $5A9_{16}$

BIT POSITION

- 3 2 1

MUL WITH BASE

- $5*16^2 + A*16^1 + 9*16^0$

DECIMAL

- 1449_{10}

ANOTHER EXAMPLE OF HEXADECIMAL TO DECIMAL

- Convert hexadecimal number 1F.01B into equivalent decimal number.
- $= (1F.01B)_{16}$
- $=(1x16^{1}+15x16^{0} +0x16^{-1}+1x16^{-2}+11x16^{-3})_{10}$
- $= (31.0065918)_{10}$

OCTAL TO DECIMAL

- 645_8

OCTAL

BIT POSITION

- 3 2 1

- $6*8^2+4*8^1$ $+5*8.^0$

MUL WITH BASE

DECIMAL

- 421_{10}

ANOTHER EXAMPLE OF OCTAL TO DECIMAL

Convert octal number 7.12172(8) into decimal form.

- 7.12172 = 7x80 + 1x8-1 + 2x8-2 + 1x8-3 + 7x8-4 + 2x8-5

  = 7 + 0.125 + 0.03125 + 0.001953125

  + 0.001708984375 + 0.00006103515624

  = 10.16 (approx. value)

Answer: (7.12172)8 = (10.16)10 (approx. value)

DECIMAL TO BINARY

Divide through out by 2

39
- Q=19
- R=1

19
- Q=9
- R=1

9
- Q=4
- R=1

4
- Q=2
- R=0

2
- Q=1
- R=0

1
- Q=0
- R=1

LSB

MSB

DECIMAL = 39_{10}
BINARY = 100111_2

ANOTHER EXAMPLE OF DECIMAL TO BINARY

Convert Decimal Number: 54.6875 into equivalent Binary Number.

- First we convert the integer 54_{10} to a binary number in the normal way using successive division through out by 2. (*Given in the previous slide*)
- Thus the binary equivalent of 54_{10} is therefore: 110110_2
- Next we convert the decimal fraction 0.6875 to a binary fraction using successive multiplication.

  0.6875 (multiply by 2) = 1.375 = 0.375 carry 1 (MSB)
  0.375 (multiply by 2) = 0.75 = 0.75 carry 0 (↓)
  0.75 (multiply by 2) = 1.50 = 0.5 carry 1 (↓)
  0.5 (multiply by 2) = 1.00 = 0.0 carry 1 (LSB)
  Thus the binary equivalent of 0.687510 is therefore: 0.10112 ← (LSB)
- Hence the binary equivalent of the decimal number: 54.6875_{10} is 110110.1011_2

DECIMAL TO HEX

Divide through out by 16

35
- Q=2
- R=3

2
- Q=0
- R=2

LSB **MSB**

DECIMAL = 35_{10}

HEX = 23_{16}

ANOTHER EXAMPLE OF DECIMAL TO HEX

Convert $(0.0628)_{10}$ decimal to hexadecimal fraction $(?)_{16}$

1st Multiplication Iteration
Multiply 0.0628 by 16 0.0628 x 16 = 1.0048(Product) Fractional part=0.0048 Carry=1 (MSD)

2nd Multiplication Iteration
Multiply 0.0048 by 16 0.0048 x 16 = 0.0768(Product) Fractional part = 0.0768 Carry=0

3rd Multiplication Iteration
Multiply 0.0768 by 16 0.0768 x 16 = 1.2288(Product) Fractional part = 0.2288 Carry=1

4th Multiplication Iteration
Multiply 0.2288 by 16 0.2288 x 16 = 3.6608(Product) Fractional part = 0.6608 Carry=3 (LSD)

Here the fractional part doesn’t become zero but we obtain required number of significant digits after the decimal point. Thus we stop the multiplication iteration and assign the weights to the digits obtained in each multiplication step in the increasing order starting from the 1st multiplication step to last multiplication step.

Carry from the 1st multiplication iteration becomes MSB and carry from 4th iteration becomes LSB after the decimal point.
Hence, the fractional hexadecimal number of the given decimal fraction (0.0628)10 is (0.1013)16

DECIMAL TO OCTAL

Divide through out by 8

461
- Q=57
- R=5

57
- Q=7
- R=1

7
- Q=0
- R=7

LSB

MSB

DECIMAL = 461_{10}
OCTAL = 715_{8}

ANOTHER EXAMPLE OF DECIMAL TO OCTAL

- Convert decimal fractional number 0.140869140625 into octal number.

Multiplication	Resultant integer part
0.140869140625 x 8=0.12695313	1
0.12695313 x 8=0.01562504	1
0.01562504 x 8=0.12500032	0
0.12500032 x 8=0.00000256	1
0.00000256 x 8=0.000020544	0
and so on	

- Now, write these resultant integer part, this will be approximate $(0.11010)_8$ which is equivalent octal fractional number of decimal fractional $(0.140869140625)_{10}$.

BINARY TO HEXADECIMAL

BINARY	4BITS DIV	HEX
• $(010111011001)_2$	• (0101)(1101)(1001)	• (5) (D) (9) $=(5D9)_{16}$

ANOTHER EXAMPLE OF BINARY TO HEXADECIMAL

Convert binary number $(001100101.110111)_2$ into hexadecimal number.

$= (001100101.110111)_2$

$= (0\ 0110\ 0101\ .\ 1101\ 1100)_2$

$= (0110\ 0101\ .\ 1101\ 1100)_2$

$= (6\ 5\ .\ D\ C)_{16}$

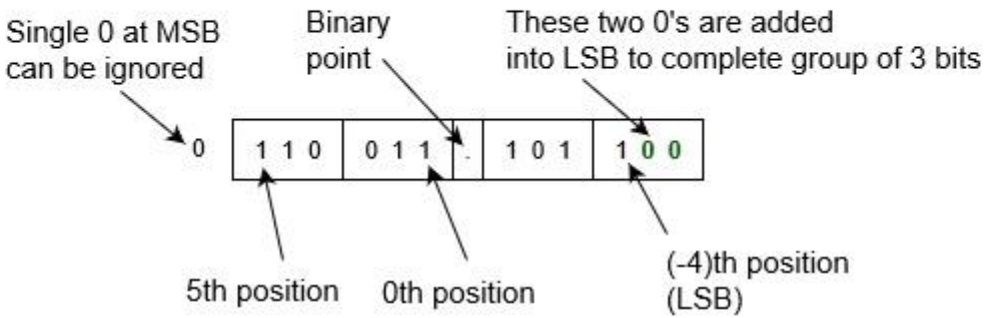
$= (65.DC)_{16}$

BINARY TO OCTAL

BINARY	3BIT DIV	OCTAL
• $(110101111100)_2$	• (110)(101)(111)(100)	• (6) (5) (7) (4) $=(6574)_8$

ANOTHER EXAMPLE OF BINARY TO OCTAL

Convert binary number 0110 011.1011 into octal number.



= (0110 011.1011)2

= (0 110 011 . 101 1)2

= (110 011 . 101 100)2 = (6 3 . 5 4)8 = (63.54)8

HEXADECIMAL TO BINARY

HEX

- $(5C)_{16}$

EXPANSION

- (0101)(1100)

BINARY

- $(01011100)_2$

ANOTHER EXAMPLE OF HEXADECIMAL TO BINARY

Convert $(FAFA.B)_{16}$ into equivalent binary number.

$(FAFA.B)_{16}=(1111\ 1010\ 1111\ 1010.1011)_2$

Leading and trailing (extreme end) zeros may be discarded.

$\therefore (FAFA.B)_{16}=(1111101011111010.1011)_2$

OCTAL TO BINARY

OCTAL	EXPANSION	BINARY
$(43)_8$	$(100)(011)$	$(100011)_2$

ANOTHER EXAMPLE OF OCTAL TO BINARY

Convert octal number 352.563 into binary number.

$(352.563)_8 = (011\ 101\ 010\ .\ 101\ 110\ 011)_2$

$= (011101010.101110011)_2$

HEXADECIMAL TO OCTAL

HEX	• $(4DF)_{16}$
EXP	• (0100)(1101)(1111)
BINARY	• $(010011011111)_2$
3BIT DIV	• (010)(011)(011)(111)
OCTAL	• $(2337)_8$

Hexadecimal to Octal

Convert Hexadecimal to Octal Value = 4DF.12E

Solution with Steps :

Convert Hexadecimal number to binary 4DF . 12E

4DF.12E16=010011011111.0001001011102

Convert Binary Number into Octal Number

- Split the binary number from left to right each group 3 bits
- 010011011111.000100101110 = 2337.04568

OCTAL TO HEXADECIMAL

OCTAL	• $(456)_8$
EXP	• (100)(101)(110)
BINARY	• $(100101110)_2$
4BIT DIV	• (0001)(0010)(1110)
HEX	• $(12E)_{16}$

OCTAL TO HEXADECIMAL

- Convert 3.07_8 into Hexadecimal Number System.
- $3.07_8 = 3 \cdot 8^0 + 0 \cdot 8^{-1} + 7 \cdot 8^{-2} = 3+0+0.109375 = 3.109375_{10}$
  Happened: 3.109375_{10}
- Happened: $0.109375_{10} = 0.1C_{16}$

  $3_{16} + 0.1C_{16} = 3.1C_{16}$

  Result of converting:
  $3.07_8 = 3.1C_{16}$

.	.109375 X 16
Take only 1	=1.75
.75 Again Multiply	.75 X16
Take 12, which is =C	=12.0
So, $0.109375_{10} = 0.1C_{16}$	

THANKS!

Any questions?