
New syllabus 2020-21

Chapter 4

# Number System & Encoding Schemes

## Computer Science

## Class XI ( As per CBSE Board)

# Number System

In general term computer represent information in different types of data forms i.e. number , character ,picture ,audio , video etc.

Computers are made of a series of switches/ gates. Each switch has two states: ON(1) or OFF(0).That's why computer works on the basis of binary number system(0/1).But for different purpose different number systems are used in computer world to represent information. E.g. Octal, Decimal, Hexadecimal.

| NUMBER SYSTEM | | |
|---|---|---|
| SYSTEM | BASE | DIGIT |
| Binary | 2 | 0 1 |
| Octal | 8 | 0 1 2 3 4 5 6 7 |
| Decimal | 10 | 0 1 2 3 4 5 6 7 8 9 |
| Hexadecimal | 16 | 0 1 2 3 4 5 6 7 8 9 A B C D E F |

# Decimal Number System

## Characteristics

- Ten symbols
- 0 1 2 3 4 5 6 7 8 9

## Positional

- $2945 \neq 2495$
- $2945 = (2*10^3) + (9*10^2) + (4*10^1) + (5*10^0)$

(Most) people use the decimal number system Why?

THIS A POSITIONAL NUMBER SYSTEM .and that's of great advantage ..simple shifting the position of decimal.It become complex either case to use number system <10 or >10.

# Binary Number System

Characteristics

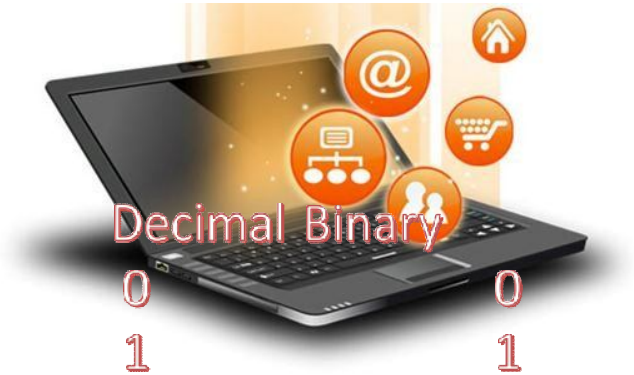
- Two symbols
- 0 1

Positional

- Positional
- $1010_2 \neq 1100_2$

Most (digital) computers use the binary number system Why?

Computers are made of a series of switches/ gates. Each switch has two states: ON(1) or OFF(0).That's why computer works on the basis of binary number system(0/1).



# Decimal-Binary Equivalence

| Decimal | Binary |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 10 |
| 3 | 11 |
| 4 | 100 |
| 5 | 101 |
| 6 | 110 |
| 7 | 111 |
| 8 | 1000 |
| 9 | 1001 |
| 10 | 1010 |
| 11 | 1011 |
| 12 | 1100 |
| 13 | 1101 |
| 14 | 1110 |
| 15 | 1111 |

| Decimal | Binary |
|---|---|
| 16 | 10000 |
| 17 | 10001 |
| 18 | 10010 |
| 19 | 10011 |
| 20 | 10100 |
| 21 | 10101 |
| 22 | 10110 |
| 23 | 10111 |
| 24 | 11000 |
| 25 | 11001 |
| 26 | 11010 |
| 27 | 11011 |
| 28 | 11100 |
| 29 | 11101 |
| 30 | 11110 |
| 31 | 11111 |

# Binary – Decimal Conversion

## Using positional notation

$$100101_2 = (1*2^5)+(0*2^4)+(0*2^3)+(1*2^2)+(0*2^1)+(1*2^0)$$

$$= 32 + 0 + 0 + 4 + 0 + 1$$

$$= 37$$

# Decimal-Binary Conversion

## Using the Division Method:

Divide decimal number by 2 until you reach zero, and then collect the remainders in reverse. $22_{10} = 10110_2$

| | Rem: |
|---|---|
| 2 ) 22 | |
| 2 ) 11 | 0 |
| 2 ) 5 | 1 |
| 2 ) 2 | 1 |
| 2 ) 1 | 0 |
| 0 | 1 |

# Hexadecimal Number System

## Characteristics

- Sixteen symbols
- 0 1 2 3 4 5 6 7 8 9 A B C D E F

Positional

$A13D_{16} \neq 3DA1_{16}$

Computer programmers often use the hexadecimal number system,Why?

Computers only work on the binary number system. The hexadecimal number system is commonly used to describe locations in computer memory. They are also used in assembly language instructions.

# Decimal-Hexadecimal Equivalence

| Decimal | Hex |
|---|---|
| 0 | 0 |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| 9 | 9 |
| 10 | A |
| 11 | B |
| 12 | C |
| 13 | D |
| 14 | E |
| 15 | F |

| Decimal | Hex |
|---|---|
| 16 | 10 |
| 17 | 11 |
| 18 | 12 |
| 19 | 13 |
| 20 | 14 |
| 21 | 15 |
| 22 | 16 |
| 23 | 17 |
| 24 | 18 |
| 25 | 19 |
| 26 | 1A |
| 27 | 1B |
| 28 | 1C |
| 29 | 1D |
| 30 | 1E |
| 31 | 1F |

| Decimal | Hex |
|---|---|
| 32 | 20 |
| 33 | 21 |
| 34 | 22 |
| 35 | 23 |
| 36 | 24 |
| 37 | 25 |
| 38 | 26 |
| 39 | 27 |
| 40 | 28 |
| 41 | 29 |
| 42 | 2A |
| 43 | 2B |
| 44 | 2C |
| 45 | 2D |
| 46 | 2E |
| 47 | 2F |

# Hexadecimal to decimal

$$25_{16} = (2*16^1) + (5*16^0)$$
$$= 32 + 5$$
$$= 37$$

## Decimal to hexadecimal

$$37 / 16 = 2 \text{ R } 5$$
$$2 / 16 = 0 \text{ R } 2$$

Read from bottom to top: $25_{16}$

# Binary - hexadecimal

| Four-bit Group | Decimal Digit | Hexadecimal Digit |
|---|---|---|
| 0000 | 0 | **0** |
| 0001 | 1 | **1** |
| 0010 | 2 | **2** |
| 0011 | 3 | **3** |
| 0100 | 4 | **4** |
| 0101 | 5 | **5** |
| 0110 | 6 | **6** |
| 0111 | 7 | **7** |
| 1000 | 8 | **8** |
| 1001 | 9 | **9** |
| 1010 | 10 | **A** |
| 1011 | 11 | **B** |
| 1100 | 12 | **C** |
| 1101 | 13 | **D** |
| 1110 | 14 | **E** |
| 1111 | 15 | **F** |

# Binary to hexadecimal

Convert $110100110_2$ to hex

Starting at the right end, split into groups of 4:

1 1010 0110 ->

0110 = 6

1010 = A

0001 = 1 (pad empty digits with 0)

$110100110_2 = 1A6_{16}$

# Hexadecimal to Binary

Convert $3D9_{16}$ to binary

Convert each hex digit to 4 bits:

3 = 0011

D = 1101

9 = 1001

0011 1101 1001

$3D9_{16} = 1111011100_{12}$ (can remove leading zeros)

# Octal Number System

## Characteristics

- Eight symbols
- 0 1 2 3 4 5 6 7

## Positional

- $1743_8 \neq 7314_8$

Computer programmers often use the octal number system,Why?

Octal and hex use the human advantage that they can work with lots of symbols while it is still easily convertible back and forth between binary.

# Decimal-Octal Equivalence

| Decimal | Octal | Decimal | Octal | Decimal | Octal |
|---|---|---|---|---|---|
| 0 | 0 | 16 | 20 | 32 | 40 |
| 1 | 1 | 17 | 21 | 33 | 41 |
| 2 | 2 | 18 | 22 | 34 | 42 |
| 3 | 3 | 19 | 23 | 35 | 43 |
| 4 | 4 | 20 | 24 | 36 | 44 |
| 5 | 5 | 21 | 25 | 37 | 45 |
| 6 | 6 | 22 | 26 | 38 | 46 |
| 7 | 7 | 23 | 27 | 39 | 47 |
| 8 | 10 | 24 | 30 | 40 | 50 |
| 9 | 11 | 25 | 31 | 41 | 51 |
| 10 | 12 | 26 | 32 | 42 | 52 |
| 11 | 13 | 27 | 33 | 43 | 53 |
| 12 | 14 | 28 | 34 | 44 | 54 |
| 13 | 15 | 29 | 35 | 45 | 55 |
| 14 | 16 | 30 | 36 | 46 | 56 |
| 15 | 17 | 31 | 37 | 47 | 57 |


# Octal to decimal

| | | | |
|---|---|---|---|
| positional powers of 8: | $8^2$ | $8^1$ | $8^0$ |
| decimal positional value: | 64 | 8 | 1 |
| Octal number: | 3 | 5 | 7 |

$$(3 \times 64) + (5 \times 8) + (7 \times 1)$$

$$= \quad 192 + 40 + 7 = 239_{10}$$

# Decimal to octal

Using the Division Method:

Example 1: $214_{10} = 326_8$

| | | |
|---|---|---|
| 8 ) 214 | | Rem: |
| 8 ) 26 | | 6 |
| 8 ) 3 | | 2 |
| 0 | | 3 |

# Binary-Octal Conversion

E.g.

$$001010000100111101_2$$

$$1\ \ 2\ \ 0\ \ 4\ \ 7\ \ 5_8$$

## Octal to binary

$$1\ \ 2\ \ 0\ \ 4\ \ 7\ \ 5_8$$

$$001010000100111101_2$$

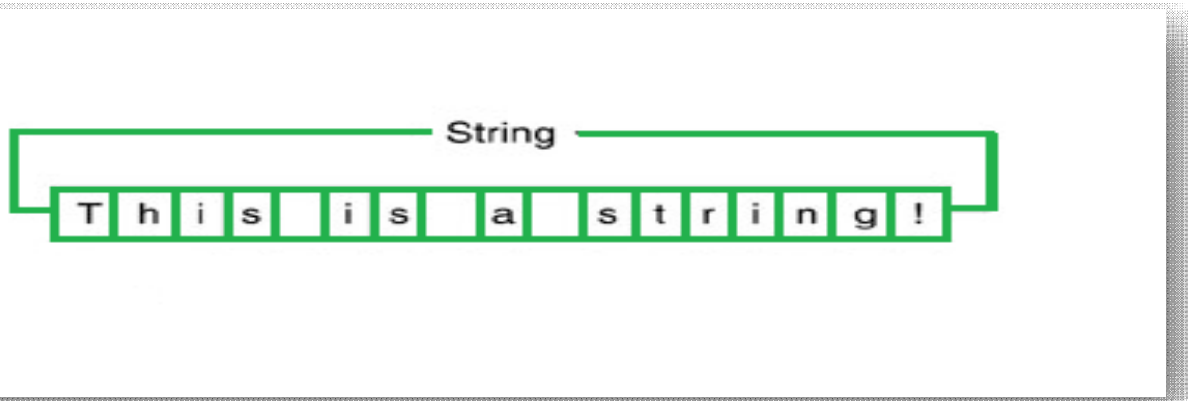
# Binary addition

| | |
|---|---|
| 1 | |
| 3 | $0011_2$ |
| + 10 | + $1010_2$ |
| 13 | $1101_2$ |

Start at right column
Proceed leftward Carry
1 when necessary

# Encoding Schemes/ String representation

String is any finite sequence of characters.Any string includes etters, numerals, symbols and punctuation marks.




Computers are designed to work internally with numbers. In order to handle characters, we need to choose a number for each character. There are many ways to do this ,which are knows as encoding schemes.

# Encoding schemes

Following are some Encoding schemes

- ASCII
- UNICODE
- ISCII

# Encoding Scheme

## ASCII

It is most common coding system (Pronounced *ass-key).*

ASCII = American National Standard Code for Information Interchange

It is Defined in ANSI document X3.4-1977. It is a 7-bit code.Its 8th bit is unused (or used for a parity bit)

$2^7 = 128$ codes

Two general types of codes:

95 are “Graphic” codes (displayable on a console)

33 are “Control” codes (control features of the console or communications channel)


# Encoding Scheme

| | 000 | 001 | 010 | 011 | 100 | 101 | 110 | 111 |
|---|---|---|---|---|---|---|---|---|
| 0000 | NULL | DLE | | 0 | @ | P | ` | p |
| 0001 | SOH | DC1 | ! | 1 | A | Q | a | q |
| 0010 | STX | DC2 | " | 2 | B | R | b | r |
| 0011 | ETX | DC3 | # | 3 | C | S | c | s |
| 0100 | EDT | DC4 | $ | 4 | D | T | d | t |
| 0101 | ENQ | NAK | % | 5 | E | U | e | u |
| 0110 | ACK | SYN | & | 6 | F | V | f | v |
| 0111 | BEL | ETB | ' | 7 | G | W | g | w |
| 1000 | BS | CAN | ( | 8 | H | X | h | x |
| 1001 | HT | EM | ) | 9 | I | Y | i | y |
| 1010 | LF | SUB | * | : | J | Z | j | z |
| 1011 | VT | ESC | + | ; | K | [ | k | { |
| 1100 | FF | FS | , | < | L | \ | l | \| |
| 1101 | CR | GS | - | = | M | ] | m | } |
| 1110 | SO | RS | . | > | N | ^ | n | ~ |
| 1111 | SI | US | / | ? | O | _ | o | DEL |

# Encoding Scheme

## ASCII CHART

MOST SIGNIFICANT BIT

| | 000 | 001 | 010 | 011 | 100 | 101 | 110 | 111 |
|---|---|---|---|---|---|---|---|---|
| 0000 | NULL | DLE | | 0 | @ | P | ` | p |
| 0001 | SOH | DC1 | ! | 1 | A | Q | a | q |
| 0010 | STX | DC2 | " | 2 | B | R | b | r |
| 0011 | ETX | DC3 | # | 3 | C | S | c | s |
| 0100 | EDT | DC4 | $ | 4 | D | T | d | t |
| 0101 | ENQ | NAK | % | 5 | E | U | e | u |
| 0110 | ACK | SYN | & | 6 | F | V | f | v |
| 0111 | BEL | ETB | ' | 7 | G | W | g | w |
| 1000 | BS | CAN | ( | 8 | H | X | h | x |
| 1001 | HT | EM | ) | 9 | I | Y | i | y |
| 1010 | LF | SUB | * | : | J | Z | j | z |
| 1011 | VT | ESC | + | ; | K | [ | k | { |
| 1100 | FF | FS | , | < | L | \ | l | \| |
| 1101 | CR | GS | - | = | M | ] | m | } |
| 1110 | SO | RS | . | > | N | ^ | n | ~ |
| 1111 | SI | US | / | ? | O | _ | o | DEL |

LEAST SIGNIFICANT BIT

# Encoding Scheme

ASCII

## “Hello, world” Example

| | Binary | Hexadecimal | Decimal |
|---|---|---|---|
| H | 01001000 | 48 | 72 |
| e | 01100101 | 65 | 101 |
| l | 01101100 | 6C | 108 |
| l | 01101100 | 6C | 108 |
| o | 01101111 | 6F | 111 |
| , | 00101100 | 2C | 44 |
| | 00100000 | 20 | 32 |
| w | 01110111 | 77 | 119 |
| o | 01100111 | 67 | 103 |
| r | 01110010 | 72 | 114 |
| l | 01101100 | 6C | 108 |
| d | 01100100 | 64 | 100 |

# Encoding Scheme

## UNICODE

It is a worldwide character-encoding standard .Its main objective is to enable a single, unique character set that is capable of supporting all characters from all scripts, as well as symbols, that are commonly utilized for computer processing throughout the world.

# Encoding Scheme

## ISCII

ISCII stands for Indian Script Code for Information Interchange for Indian languages. It is an 8-bits code to represent Indian scripts.

The Department of Electronics (DOE) has established standard and standard are in action from 1983.

These codes are used for 10 Indian scripts- Devanagri, Punjabi, Gujrati, Udia, Bengali, Asami, Telgu, Kannad, Malayalam and Tamil. C-DAC (established in August-September, 1988) developed standard for font coding in 1990 is called ISFOC (Indian Standards for Font Coding).