Musaeus College – Colombo 07
Grade 12 1st Year
Study Pack - ICT

Please copy following note :

History of Computers

Calculating aids – Pre mechanical era – before 1450

Abacus is considered as the first calculating device in the world used by Chinese around 5000 BC.

Mechanical era – 1450-1840

The Pascaline was introduced by Blaise Pascal in 1642. It could add and subtract two numbers.

The Stepped Reckoner invented by German scientist Gottfried Wilhelm Leibniz completed in 1694. This device is carried out the operations add, subtract, multiply and divide too.

The difference engine, the first mechanical computer was developed by Charles Babbage in 1880.

He presented the concept of Input, Process and Output that is used in modern computers, for the first time. Therefore, he is considered as the "Father of the computer".

Electro mechanical era – 1840 – 1940

Electronic valve (vacuum tube) invented by Forest in 1906.

The automatic sequence controller (Mark 1) was the first automatic computer invented by Professor Howard Aiken in 1939.

Electronic Era

1st Generation Computers (1940-1956)

The computers of first generation used vacuum tubes as the basic component.

- ENIAC (Electronic Numerical Integrator and Calculator) was the first electronic digital computer designed by John Mauchly and J. Presper Eckert in 1946.
- EDSAC **(**Electronic Delay Storage Automatic Calculator) was the first full size stored program computer developed by Maurice Wilkes in 1947. EDSAC was built according to the von Neumann machine principles.
- EDVAC (Electronic Discrete Variable Automatic Computer) is considered as the first digital computer that could store program was built in 1948.

- UNIVAC (Universal Automatic Computer) was an electrical computer containing thousands of vacuum tubes that utilized punch cards and switches to input data and punch cards to output and store data.

2nd Generation Computers (1956 – 1963)

In this generation, transistors were used as the fundamental building block.

IBM 1620, IBM 7094, CDC 1604, CDC 3600, UNIVAC 1108 were some computers developed in this generation.

3rd Generation Computers (1964 – 1975)

The computers of third generation used Integrated Circuits (ICs) in place of transistors. A single IC contains many transistors, resistors, and capacitors along with the associated circuitry.

IBM-360 series, PDP (Personal Data Processor), TDC-316 were the computers of 3rd generation.

4th Generation (1975 – 1989)

In this generation of computers VLSI (Very Large Scale Integrated) circuits were used. VLSI circuits having more transistors and other circuit elements with their associated circuits on a single chip made it possible to have microcomputers.

Eg: DEC 10, STAR 1000, PDP 11

5th Generation Computers (1989 – present)

The ULSI (Ultra Large Scale Integration) technology is used in this generation resulting in the production of microprocessor chips having millions transistors and other electronic components.

Eg: Desktop, Laptop, Notebook, Ultrabook

Classification of Computers

1. Based on the Technology
    - (i) Analog Computer - An analog computer is a form of computer that handles *continuous* values such as electrical, mechanical, or hydraulic quantities.
    - (ii) Digital Computer - A computer that performs calculations and logical operations with quantities represented as digits, usually in the binary number system.

2. Based on the Purpose
    (i) Special purpose computer - Computers are designed to handle a specific problem or to perform a specific task.
    (ii) General purpose computer – These are designed to perform a range of tasks.

3. Based on Size
    (i) Super Computer - The fastest and most powerful type of computers Supercomputers are very expensive and are employed for specialized applications that require immense amounts of computing power. (Eg: **TIANHE-1**)
    (ii) Mainframe Computer - A very large and expensive computer capable of supporting hundreds, or even thousands, of users simultaneously.
    (iii) Mini Computer – Mid size computers mainly used as small or midrange servers operating business and scientific applications.
    (iv) Micro Computer –

        Desktop – A personal computer sufficient to fit on a desk

        Laptop – A portable computer

        Palmtop – A hand size computer

        Notebook - A portable computer small and thinner than Laptop.

        Smart phone – This is a mobile phone used for mobile communication with an operating system and other advanced facilities.

        Tablet - A tablet is a wireless, portable personal computer with a touch screen interface. The tablet is typically smaller than a notebook computer, but larger than a smartphone.

        Phablet - A *phablet* is a small pocket sized mobile device that is a bit larger than the size of an average smartphone and smaller than tablet. (Eg: Apple 6Plus, Galaxy Note, etc)

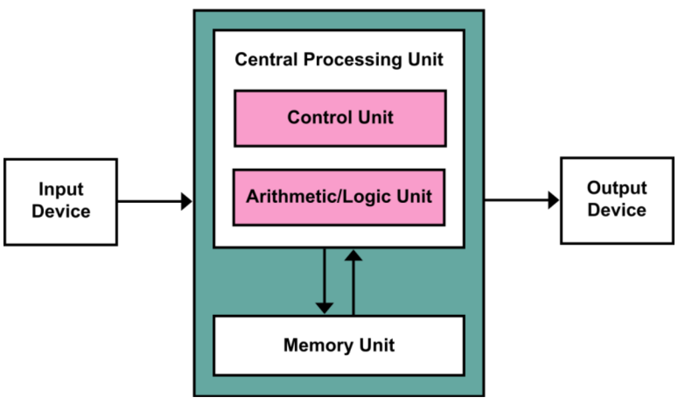
2. Evaluation
MCQ
2011 -1,2,3,4 , Part A- 1(a)
2015-1,2
2012-1,2
2013-7
2014-1,2
2016-1
2017-1
2018 – No mcqs for history lesson

Competency 2: Explores the evolution of computing devices, so as to be able to describe and compare the performance of modern computers.

Competency Level 2.3: Explores the Von- Neumann Architecture**.**

Von-Neumann Architecture

Von Neumann Architecture consists of a CPU, memory and input output devices. The program is stored in the memory. The CPU fetches an instruction from the memory at a time and executes it.



(Source; https://en.wikipedia.org/wiki/Von_Neumann_architecture)

Major components of this architecture:

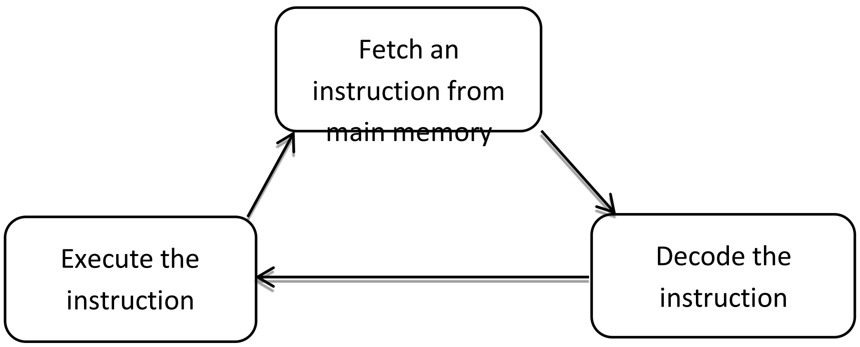
1. Central processing unit
   (i) Control unit (CU)
   This unit controls signals of all devices of a computer system.
   (ii) Arithmetic and logic unit (ALU)
   It carries out mathematical and logical operations.
   (iii) Memory register
   A CPU register is one of a small set of data holding places which is part of the computer processor. A register may hold an instruction, a storage address, or any kind of data

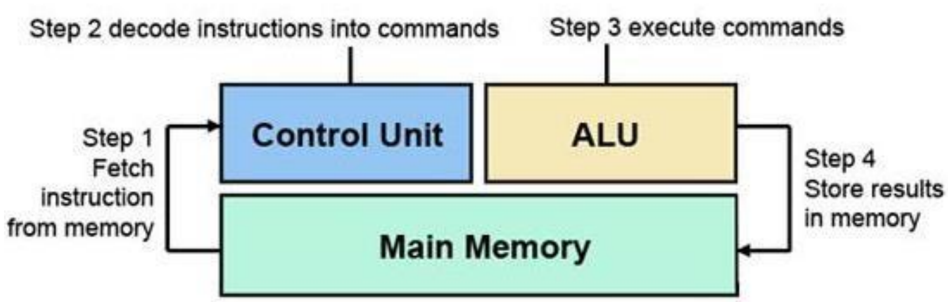
2. Memory
   (i) Primary memory
   (ii) Secondary memory
3. Input device
4. Output device

Data bus
A data bus is a system within a computer or device, consisting of a connector or set of wires, that provides transportation for data.

Control bus
Control bus is used to transmit a variety of control signals to components and devices.(leave one page to write a note in your note book)

Fetch execute cycle





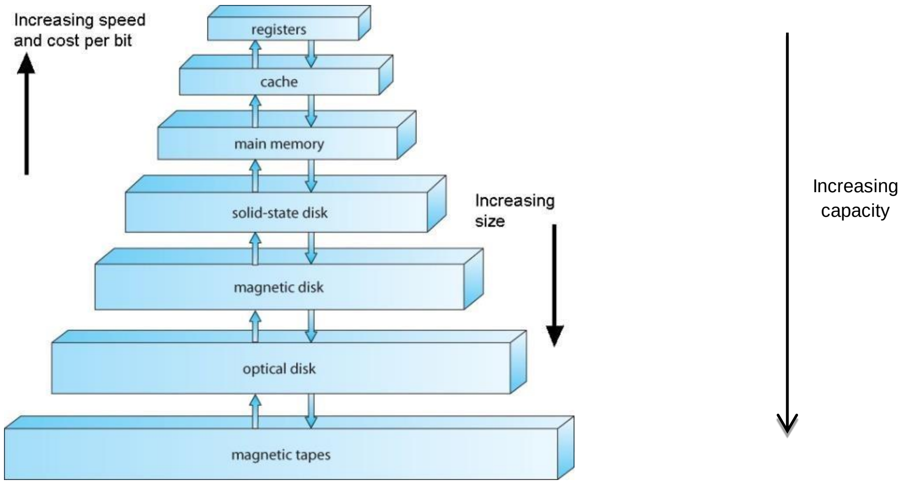
Multi-core processors

A multi-core processor is a single computing component with two or more independent actual processing units (cores), which are units that read and execute program instructions. Therefore, the single processor can run multiple instructions on separate cores at the same time.

Need of multi-core processor

1. Can be run a program by dividing some parts. So it gets executed fast.
2. It enables parallel programming.
3. To get the high performance from a single machine.

Memory hierarchy



Volatile memory

Volatile memory is a computer storage that only holds the data while the device is powered.

Eg: Register, Cache memory, RAM

Cache memory

The cache memory is used to store program instructions that are frequently accessed by software during operation.

Types of cache memories

- Level 1 **(L1)** cache is extremely fast but relatively small, and is usually embedded in the processor chip (CPU).
- Level 2 (L2) cache is often more capacity than L1. It may be located on the CPU or on a separate.
- Level 3 (L3) cache is typically specialized memory that works to improve the performance of L1 and L2. It can be significantly slower than L1 or L2, but is usually double the speed of RAM.

RAM (Random Access Memory)

RAM is the main memory of the computer that holds data for running applications and required data for a computer. Types of RAM

(i) SRAM – Static RAM

SRAM is random access memory that retains data bits in its memory as long as power is being supplied. SRAM is used for cache memory and register memory.

(ii)DRAM – Dynamic RAM

This type of RAM is continuously refreshed or it will lose its contents.

(iii) SDRAM - Synchronous DRAM

It is a type of memory that synchronizes itself with the computer's system clock. (Leave one page to write a note)

Non-volatile memory

This is a type of computer memory that has the capability to hold saved data even if the power is turned off.

Eg: ROM, Hard disk etc.

ROM – Read Only Memory

ROM retains its contents even when the computer is turned off. ROM stores essential programs such as the program that boots the computer.

Types of ROM

PROM (Programmable ROM)

It is a memory chip on which data can be written only once. Once a program has been written onto a PROM, it remains there forever.

EPROM (Erasable PROM)

EPROM is a special type of memory that retains its contents until it is exposed to ultraviolet light. The ultraviolet light clears its contents, making it possible to reprogram the memory.

EEPROM (Electrically Erasable PROM)

IT can be erased by exposing it to an electrical charge. (Leave one page to write a note)

Secondary storage

1. Magnetic storage device

Magnetic storage is the manipulation of magnetic fields on a medium in order to record audio, video or other data. In main computer storage mechanisms have generally involved a spinning disc or platter and read write heads on an armature. Many types of magnetic storage involve a tape medium ether on a real or in a cassette that is moved by read and write heads.

Eg: Hard disk, Floppy disk, Magnetic tape(Leave two pages to write a note)

2. Optical storage device

Optical storage is any storage method in which data is written and read with a laser for archival or backup purposes. Typically, data is written to optical media, such as CDs and DVDs. For several years, proponents have spoken of optical storage as a near-future replacement for both hard drives in personal computers and tape backup in mass storage. Optical media is more durable than tape and less vulnerable to environmental conditions. On the other hand, it tends to be slower than typical hard drive speeds, and to offer lower storage capacities. (Leave one page to write a note)

Eg: CD, DVD, Blu-Ray disc

3. Solid state storage

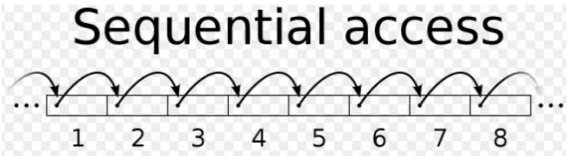
Solid-state storage (SSS) is a type of computer storage media made from silicon microchips. SSS stores data electronically instead of magnetically, as spinning hard disk drives (HDDs) or magnetic oxide tape do. Solid-state storage can be found in three form factors: solid-state drives (SSD), solid-state cards (SSC) and solid-state modules (SSM). An important advantage of solid-state storage is that it contains no mechanical parts, allowing data transfer to and from storage media to take place at a much higher speed and providing a more predictable lifespan for the storage media. Because there are no moving parts, SSDs produce far less heat than HDDs. Eg: Flash drive, Memory card

Memory Access method

(i) Sequential access

Start at the beginning and read through in order.

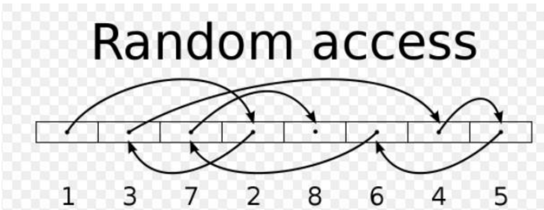
Eg: Tape



(ii) Random access

Individual addresses identify directly and access the data immediately,

Eg: RAM



Evaluation

2011-22,29,30,31,42,33,14,part A-1(b)

2015-5,6,8,9,26,35,
2012-3,4,28,2941
2013-5,6,7,8,31,3233,34
2014-14,15,16,43
2016-2,5,6,8,9,26,35
2017-2,4,125,6,7,8,38,39
2018-3,4,12,13,18,19,20,36,37,50

Competency 3: Investigates how instructions and data are represented in computers and exploit them in arithmetic and logic operations

Digital devices represent everything as numbers.

– Numbers, characters, symbols, images, audio and video and all the multimedia items and instructions are represented by numbers in digital devices.

All modern digital devices use binary numbers (base 2) instead of decimal (base 10) Smallest unit in digital device is bit.

– A bit is a "binary digit", that is, a number that is either 0 or 1
– Computers ultimately represent and process everything as bits

Groups of bits represent larger things

– Numbers, letters, words, names, pictures, sounds, instructions,..
– The interpretation of a group of bits depends on their context

Humans need different number systems to interact with computers. Humans can't remember large set of ones and zeros ("1" and "0"). Binary files are difficult for humans to read and edit. Binary files can get confusing when transferring between computers with different architectures. By using octal and hexadecimal numbers humans can easily read.

Decimal Numbers

- The number system is extremely close to our day to day life.
- It is made up of the digits of 0,1,2,3,4,5,6,7,8,9
- It is called the decimal number system because ten digits available in this number system
- It can be believed that it has become a popular number system because humans have ten fingers in their hand.
- However, a large number can be represented using these ten digits.
- The decimal point is used to separate a fractional part of a number
- Plus "+" sign used to show positive values and negative "-" sign is used to show negative values. E.g. :- +10.235
  -25.321

Integers

- Integers are a number set.
- Natural numbers (0, 1, 2, 3...) and (-1,-2,-3,…) are integers.
- Neither decimal number nor fractions are integers.

E.g. :- 0.75, 8.5

Decimal number system

- This number system has 10 digits of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.
- When the value of a particular number exceeds the largest number 9 in that number set, the multiples of 10 of the number of values are transferred to the next (left) place value. Every place value is multiplied by ten to get the next place value.

E.g. :- 3456 $= 3 \times 10^3 + 4 \times 10^2 + 5 \times 10^1 + 6 \times 10^0$

$= 3000 + 400 + 50 + 6$

$= 3456$

The place values in decimal number are multiple values of 10. Therefore the base value of the decimal number system is 10.

Binary number system

- The binary number system has two digits which can be represent two states.
- These two states are, represented by digits "0" and "1".
- Therefore a number system with the two digits can be used here.
- There are multiplications of 2 in place values of the binary number system. They are as follows.

2_4 2_3 2_2 2_1 2_0 2_{-1} 2_{-2} 2_{-3} 16 8 4 2 1 1/2 1/4 1/8 Place values

- Therefore, the base value of the binary number system is 2.
- As the computer works on electricity and is an electronic device, its functions are controlled by two states.
- These two states are, where the power is ON and OFF (As two different levels of voltage)
- The every place value is multiply by 0 or 1 (digits of binary number system) to get the value of binary number.

E.g. :- 11010_2 $= 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$

$= 1x16+1x8+0x4+1x2+0x1$

$= 26_{10}$

Therefore, $11010_2 = 26_{10}$

One location (one digits) is call a bit. There are 5 bits in the above number.

Octal number system

- The base value of the octal number system is 8.

- The digits are 0, 1, 2, 3, 4, 5, 6 and 7.
- The place values are as follows.

8^2	8^1	8^0	8^{-1}	8^{-2}	
64	8	1	1/8	1/64	place values

E.g. :- $673_8 = 6 \times 8^2 + 7 \times 8^1 + 3 \times 8^0$

$= 6x64+7x8+3x1$

$= 443_{10}$

Therefore, $673_8 = 443_{10}$

Hexadecimal number system

- The base value of hexadecimal number system is16.
- There are 16 digits in the hexadecimal number system. Digits over value 9 need two digits. Therefore, A, B, C, D, E, F also used as remaining digits. All digits are as follows.

  Digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- The minimum value is 0 and maximum value is F ($=15_{10}$).
- The values represented by the digits are as follows

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

E.g. :- $BC12_{16} = B(11) \times 16^3 + C(12) \times 16^2 + 1 \times 16^1 + 2 \times 16^0$

$= 11\times16^3 + 12\times16^2 + 1\times16^1 + 2\times16^0$

$= 11x4096 + 12 x256+ 1x16+2x1$

$= 45056 + 3072 + 16 + 2$

$= 48146$

Therefore, $BC12_{16} = 48146_{10}$

The Decimal number 765.43 can be tabulated as follows.

	100	10	1	1/10	1/100	
Place Value	10^2	10^1	10^0	10^{-1}	10^{-2}	
Numbers	7	6	5	4	3	
Value	700	60	5	0.4	0.03	765.43

Most Significant Digit (MSD) and Least Significant Digit (LSD)

MSD - The Digit that contain the most positional value in a number.

LSD - The Digit that contains the least positional value in a number.

0.03145	3	5
0031.0060	3	6
Number	**MSD**	**LSD**
2975.0	2	5
56.034	5	4

E.g.:-

Conversions between number systems (leave one page for more exercises in each number conversion)

1. Conversion of a decimal numbers into a binary numbers

- Divide the given decimal number by 2
- Write the integer answer (quotient) under the long division symbol.
- Write the remainder (0 or 1) to the right of the dividend.
- Continue downwards, dividing each new quotient by 2 and writing the remainders to the right of each dividend. Stop when quotient is 0.
- Starting from bottom, write the sequence of 1's and 0's upwards to the top.

E.g.:- Converting number 12_{10} to a binary number.

First, divide this number by 2 writing the remainders.

2 ____ 12 Remainder

2 0 6

2 3 0

2 1 1

0 1

↑

Quotient

$12_{10} = 1100_2$

2. Conversion of a decimal numbers into a Octal numbers

- Divide the given decimal number by 8
- Write the integer answer (quotient) under the long division symbol.
- Write the remainder (0 to 7) to the right of the dividend.
- Continue downwards, dividing each new quotient by 8 and writing the remainders to the right of each dividend. Stop when quotient is 0.
- Starting from bottom, write the sequence of remainders upwards to the top.

E.g.:- Converting number 245_{10} into an octal number.

		Remainder
8	245	
8	30	5
8	3	6
	0	3

$245_{10} = 365_8$

Quotient

3. Conversion of a decimal numbers into a Hexadecimal numbers

- Divide the given decimal number by 16. Treat the division as an integer division.
- Write down the remainder (in hexadecimal, i.e. if the remainder is 12, write down "C").
- Repeat step a and b until the result is 0.
- The hexadecimal value is the digit sequence of the remainders from the bottom to top.

E.g.:- Converting number 3240_{10} into a hexadecimal number.

		Remainder
16	3240	
16	202	8
16	12	10 (A)
	0	12 (C)

Quotient

$3240_{10} = CA8_{16}$

Converting fractions to Binary

- Multiply the given decimal fraction by 2.
- Multiply by 2 until the decimal part becomes 0.
- Write the values in front of decimal point from beginning to end.

E.g.:- convert 0.3125_{10} to binary

$0.3125_{10} = 0.0101_2$

	0.3125	x2
0	.625	x2
1	.25	x2
0	.50	x2
1	.00	

Converting fractions to Octal

- Multiply the given decimal fraction by 8.
- Multiply the decimal by 8 until it becomes 0.
- Write from the beginning to end, the values in front of the decimal point.

E.g. :- convert 0.3125_{10} to binary

0	0.3125	x8
2	.50	x8
4	.0	x8

$0.3125_{10} = 0.24_8$

Converting Binary Numbers to Decimal Numbers

E.g.:- Converting number 1101_2 to a decimal number.

$1 \quad 1 \quad 0 \quad 1_2$

$2^3 \quad 2^2 \quad 2^1 \quad 2^0$ ← Place values

$1101_2 = (1x2^3) + (1x2^2) + (0x2^1) + (0x2^0)$

$= (1x8) + (1x4) + (0x2) + (1x1)$

$= 8 + 4 + 0 + 1$

$1101_2 = 13_{10}$

Converting Octal Numbers to Decimal Numbers

E.g.:- Converting number 1260_8 to a decimal number.

$1 \quad 2 \quad 6 \quad 0_8$

$8^3 \quad 8^2 \quad 8^1 \quad 8^0$ ← Place values

$1260_8 = (1x8^3) + (2x8^2) + (6x8^1) + (0x8^0)$

$= (1x512) + (2x64) + (6x8) + (0x1)$

$= 512 + 128 + 48 + 0$

$1260_8 = 688_{10}$

Converting hexadecimal Numbers to Decimal Numbers

E.g.:- Converting number $A0B1_{16}$ to a decimal number.

$A(10) \quad 0 \quad B(11) \quad 1_{16}$

$16^3 \quad 16^2 \quad 16^1 \quad 16^0$ ← Place values

$A0B1_{16} = (10x16^3) + (0x16^2) + (11x16^1) + (1x16^0)$

$= (10x4096) + (0x256) + (11x16) + (1x1)$

= 40960 + 0 + 176 + 1

$A0B1_{16} = 41137_{10}$

Converting Binary Numbers to Octal Numbers

Group all the 1's and 0's in the binary number in sets of three, starting from the far right. Add zeros to the left of the last digit if you don't have enough digits to make a set of three. Next assuming all groups a different 3 digit binary number multiply it by place values and get the sums separately. Put everything back together to get the octal number.

E.g. :- 10011011_2

Grouping: $10,011,011_2$

Adding Zeros for Groups of Three: $010, 011, 011_2$

$=(0x2^2+ 1x2^1 + 0x2^0), (0x2^2+ 1x2^1 + 1x2^0), (0x2^2+ 1x2^1 + 1x2^0)$

=(0+2+0), (0+2+1), (0+2+1)

=2, 3, 3

$=233_8$

Converting Binary Numbers to hexadecimal Numbers

Cut your string of binary numbers into groups of four, starting from the right.
Add extra zeros to the front of the first number if it is not four digits.
Convert one 4-digit group at a time and change to hexadecimal digits. Put everything back together to get the hexadecimal number E.g.:- Convert 11101100101001_2 to hexadecimal

Grouping: 11,1011,0010,1001
= 0011,1011,0010,1001

$=(0x2^3 +0x2^2 +1x2^1 +1x2^0), (1x2^3 +0x2^2 +1x2^1 +1x2^0), (0x2^3 + 0x2^2 +1x2^1 +0x2^0), (1x2^3 + 0x2^2 +0x2^1 +1x2^0)$

= (0+0+2+1), (8+0+2+1), (0+0+2+0), (8+0+0+1)

= 3, 11, 2, 9

$= 3B29_{16}$

Therefore $11101100101001_2 = 3B29_{16}$

Converting Octal Numbers to Binary Numbers

Octal Number (Digit)	**Binary Number**
0	000
1	001
2	010

3	011
4	100
5	101
6	110
7	111

Write the equivalent three binary digits groups for each octal digit. Remove the zeros from left which has no values. Put all together to get the binary equivalent number.

137_8 = 001,011,111

= 001011111_2

= 1011111_2

Converting hexadecimal Numbers to Binary Numbers

Write the equivalent four binary digits groups for each hexadecimal digit.

Remove the zeros from left which has no values.

Put all together to get the binary equivalent number.

$1A90_{16}$ = 0001,1010,1001,0000

= 0001101010010000_2

= 1101010010000_2

For negative numbers we need an alternative interpretation of bit values. Three interpretations have been used:

Sign-Magnitude.

The sign and magnitude method is commonly an 8 bit system that uses the most significant bit (MSB) to indicate a positive or a negative value. By convention, a ‘0’ in this position indicates that the number given by the remaining 7 bits is positive, and a most significant bit of ‘1’ indicates that the number is negative. This interpretation makes it possible to create a value of negative zero.

E.g. :- $+45_{10}$ in signed binary is 00101101_2

- 45_{10} in signed binary is 10101101_2

Evaluation-

Mcq

2013-20

2014-6

2016-3

2017-3,9,11

2018-1,2