

Week 1:

Assignment 1:

Answer: I have an Acer Swift 3 laptop as my working computer. It comes with Intel i5 –8250U CPU at 1.60Ghz speed. It also consists of Intel UHD 620 Graphics with 8 GB RAM and 512 GB SSD.

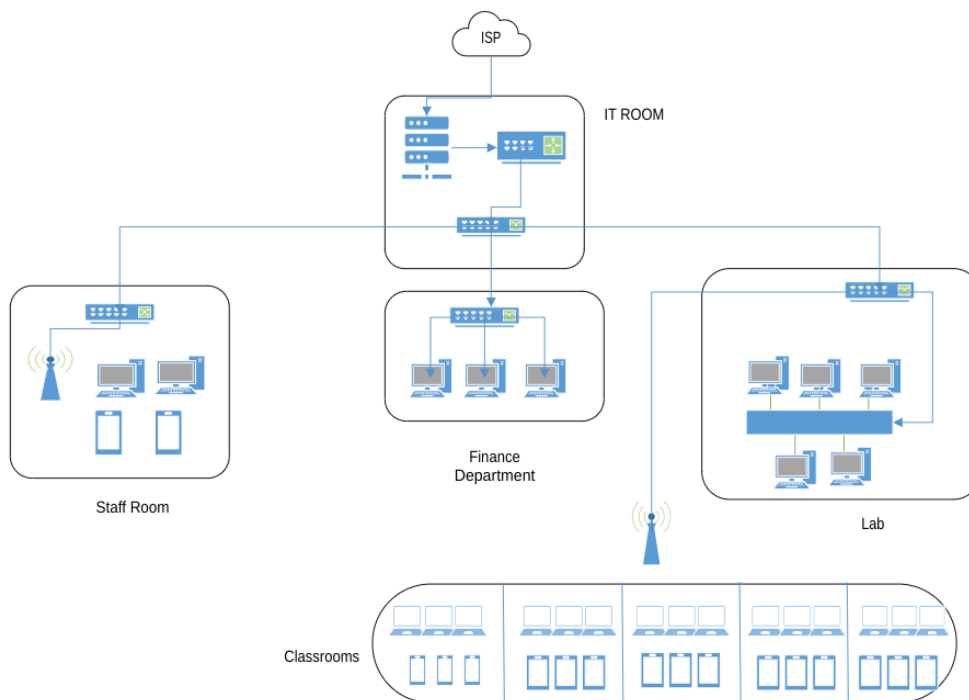
Yes, I have built my own computer. It was a challenging task for me for the first time but with some help I was able to build it without any damage or failure. Building my own computer taught me a lot about its various parts.

I personally prefer Linux as my operating system. It is an open-source operating system which is highly customizable and secure. It is mostly popular among developers as it can be easily customized according to their needs which is difficult in other operating systems. Being an open-source OS, it is free and can be easily downloaded without any licensing fees. It also includes a strong Command Line Interface, which makes it easier for developers to work on complex operations. Linux is known for its fast performance as it requires low resources and gives more flexibility to the users.

Week 2:

Assignment 1:

Answer: This is a general representation of the school system. The school has a main IT Room with a server and router which provide network to all other departments. It also holds all the information about teaching & non-teaching staff, students and all the other members of the school on its server. It is managed by a network administrator. They give a different network to each department so that one department can't access the information of another department. The staff and management room has its own switch and wireless router, which is connected to PCs, printer etc. This department is mainly concerned with the learning materials and examination materials. The finance department is mostly responsible for the fees and other monetary parts. And the third switch is connected to student's lab and wireless router is connected to student's classrooms to access internet.



(Made in Visio)

Some of the major environmental factors that might affect the organization's computer system are cybersecurity threats, robbery, budgetary constraint, organization's culture and virus. Cyberattack in school's database server can leak private information about its student and staff. Organizations must invest a good

amount in making the IT system better and prevent an attack from happening. New advanced technology must be implemented, which might be a problem if the organization has a limited budget. The cooperation of its staff and their loyalty is also very important for an organization. These might be some of the environmental factors that might affect the system of the organization.

Week 3:

Assignment 1:

Answer:

Binary to Hexadecimal:

$$(101000101100)_2 \rightarrow (?)_{16}$$

Solution:

To convert into hexadecimal, we divide it into three parts of four digits from right to left:

1010 0010 1100:

$$\text{First part: } 1 * 2^3 + 0 * 2^2 + 0 * 2^1 + 1 * 2^0 \Rightarrow 8 + 0 + 0 + 1 \Rightarrow 9 \Rightarrow \text{A}$$

$$\text{Second Part: } 0 * 2^3 + 0 * 2^2 + 1 * 2^1 + 0 * 2^0 \Rightarrow 0 + 0 + 2 + 0 \Rightarrow 2$$

$$\text{Third Part: } 1 * 2^3 + 1 * 2^2 + 0 * 2^1 + 0 * 2^0 \Rightarrow 8 + 4 + 0 + 0 \Rightarrow 12 \Rightarrow \text{C}$$

$$\text{Therefore, } (101000101100)_2 = (\text{A2C})_{16}$$

Hexadecimal to binary:

$$(\text{A2C})_{16} = (?)_2$$

Solution:

$$\text{A} = 1010$$

$$2 = 0010$$

$$\text{C} = 1100$$

$$\text{Therefore, } (\text{A2C})_{16} \Rightarrow (101000101100)_2$$

Here, the original binary is equal to the calculated binary.

Assignment 2:

Answer:

Binary to Hexadecimal

$$(1111001101100)_2 = (?)_{16}$$

Divide the given number into four digits from right to left,

$$\text{First part: } 1100 \Rightarrow 1 * 2 + 1 * 2 + 0 * 2 + 0 * 2 \Rightarrow 8 + 4 + 0 + 0 \Rightarrow 12 \Rightarrow C$$

$$\text{Second Part: } 0110 \Rightarrow 0 * 2 + 1 * 2 + 1 * 2 + 0 * 2 \Rightarrow 0 + 4 + 2 + 0 \Rightarrow 6$$

$$\text{Third Part: } 1110 \Rightarrow 1 * 2 + 1 * 2 + 1 * 2 + 0 * 2 \Rightarrow 8 + 4 + 2 + 0 \Rightarrow 14 \Rightarrow E$$

$$\text{Fourth Part: } 0001 \Rightarrow 0 * 2 + 0 * 2 + 0 * 2 + 1 * 2 \Rightarrow 0 + 0 + 0 + 1 \Rightarrow 1$$

$$\text{Therefore, } (1111001101100)_2 = (1E6C)_{16}$$

Hexadecimal to Binary

$$(1E6C)_{16} = (?)_2$$

Solution:

$$1 = 0001$$

$$E = 1110$$

$$6 = 0110$$

$$C = 1100$$

$$\text{Therefore, } (1E6C)_{16} = (0001111001101100)_2$$

Here, the calculated binary is equal to the original binary number.

Assignment 3:

Answer:

$$1 - 4E$$

Solution:

$$4E = 4 * 16^1 + E * 16^0 \Rightarrow 4 * 16 + 14 * 1 \Rightarrow 64 + 14 \Rightarrow 78$$

$$\text{Therefore, } (4E)_{16} = (78)_{10}$$

$$2- 3D7$$

Solution:

$$3D7 = 3 * 16^2 + D * 16^1 + 7 * 16^0 = 3 * 256 + 13 * 16 + 7 * 1 = 768 + 208 + 7 = 983$$

$$\text{Therefore, } (3D7)_{16} = (983)_{10}$$

$$3- 3D70$$

Solution:

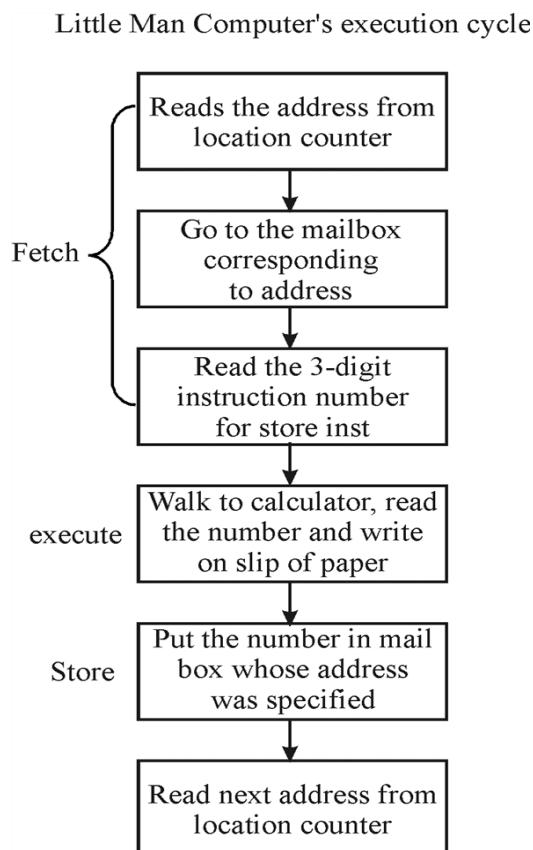
$$3D70 = 3 * 16^3 + D * 16^2 + 7 * 16^1 + 0 * 16^0 = 3 * 4096 + 13 * 256 + 7 * 16 + 0 * 16 = 768 + 208 + 7 + 0 = 15728$$

Week 4 & 5:

Assignment 1:

Answer: In LCM, there are mainly three parts in a cycle. Firstly, there is an in and out basket which holds the instruction given by the user. It sends the instruction to the mailbox according to its address. The data is read and sent to accumulator for calculation and is sent to mailbox to store it. In this way, little man computer's execution cycle takes place.

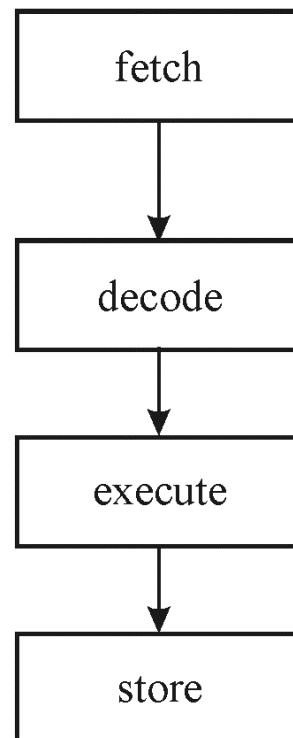
Flow diagram of Little Man



Source: Chegg.com

Fetch-Execute Cycle of CPU

CPU Fetch-Execute Cycle



In CPU fetch-execute cycle, there are mainly four parts to how a cycle is completed. In first, the instruction is fetched from memory and computer tries to understand what instruction to perform. It retrieves the address from the program

counter and passes to the instruction register to fetch the cycle. The data fetched is then decoded and sent forward. The execute is used to execute the instruction that is fetched and decoded. At last, the executed instruction is stored in memory location.

Assignment 2:

Answer: The CPU in today's computers has memory built in, known as cache memory. The memory size of cache is very small but is of very high speed. It is used for accessing frequently used data. Due to limited capacity and expensiveness, it cannot be used in enormous amounts. Cache memory is used to store frequently used data and instruction that the CPU can access quickly instead of retrieving from slow memory (RAM). There are several levels of cache memory, having different capacities and speeds. L1 cache has the smallest capacity but is fastest, while L2 or L3 cache have higher capacity with slower speed compared to L1. Since cache memory is built in CPU, it is closer to the CPU and reduces the time to access the data and improve the performance of the system. It also reduces the overall consumption of power which might be required if we had to access data from the main memory.

Since cache memory has limited capacity and is expensive, it is not practical to include large amount in a system. So, computers have additional memory, called RAM (Random Access Memory), which is located on the motherboard. It has a larger memory capacity than cache but is also slower. RAM is located outside of CPU to allow flexibility and scalability. Keeping RAM separate from CPU allows the user to easily upgrade and expand the memory capacity of the system.

Many systems nowadays include a GPU and separate video memory for better graphics and video performance. A GPU (Graphics Processing Unit) is a special processor designed to handle complex calculations and render graphics and videos in better quality. Whereas a video memory is a type of memory that stores images and video. Computer systems back in the days used to have a single CPU for every processing operation. But nowadays, there are separate processors and memory for separate operations. By specialized processor and memory like GPU and video memory, it increases the operation's quality and frees the load of CPU, increasing the system's performance.

Activity I:

Answer: The program to ADD and SUB instruction of the LMC instruction set:

-> Addition of 2 number

INP	(reads 1 st number)
STA A	(stores in memory at address A)
INP	(read 2 nd number)
STA B	(stores in memory at address B)
LDA A	(Loads 1 st number in accumulator)
ADD B	(Add 2 nd number in accumulator)
OUT	(Output the sum)
HLT	(Halt the program)
A DAT	(Memory location of A)
B DAT	(Memory location of B)

-> Subtraction of 2 number

INP	(reads 1 st number)
STA A	(stores in memory at address A)
INP	(read 2 nd number)
STA B	(stores in memory at address B)
LDA A	(Loads 1 st number in accumulator)
SUB B	(Subtract 2 nd number from accumulator)
OUT	(Output the sum)
HLT	(Halt the program)
A DAT	(Memory location of A)
B DAT	(Memory location of B)

Week 6 & 7

Assignment 1:

Ans: If we were to build a computer for outer space, both flash and RAM as memory might be used.

Flash memory is a non-volatile memory, which means the data can still be stored in case of any power outage. It keeps the data even if the power is unavailable by storing it in a special memory cell that uses an insulated gate to trap the electric signal. It would be used to store important data that might be needed even in the case of power shortage or other interruption. It is also resistant to radiation which is a major concern in outer space.

In contrast, Random Access Memory (RAM), is a volatile memory that requires constant power supply to keep data and information. It is faster than flash memory, which makes it a better option to store data which needs to be accessed frequently.

We can say that both flash and RAM memory have their own advantages and disadvantages, so a good balance of both memories might be perfect while building a computer for outer space.

Assignment 2:

One large modern computer has a 48-bit memory address register. How much memory can this computer address?

Ans: One large modern computer with 48-bit memory address register can address a maximum of 2^{48} memory locations (i.e., $2^{48} = 281,474,976,710,656$ bytes). So, the total amount of memory that can be addressed is 256 TB.

Assignment 3:

What are the criteria that define von Neumann architecture? How does the example in this chapter in which we enter and add two numbers illustrate each of the criteria?

Ans: Von Neumann architecture is a system architecture based on stored program concept where program data and instruction are stored in same memory. Some of the criteria that defines von Neumann architecture are described below:

- i. It uses CPU that can perform basic arithmetic, logical, and control flow operation.
- ii. It uses stored memory concept that is organized as linear sequence with unique address.
- iii. It has an instructional set to understand, execute and perform operation on data.
- iv. It has an I/O system which allows input/output to communicate with memory.

Activity II (HOME):

Ans: Moore's Law states that the number of transistors on a microchip double increasing speed and performance about every two years while the price gets halved. This law has been used for decades, and experts suggest it will end very soon.

Assuming Moore's law is ending, there are many technologies that could emerge and be the next massive thing. Some of them are mentioned below in detail:

- i. Quantum Computing: It uses quantum mechanisms to perform calculations. It has potential to solve complex operations, such as breaking encryption, optimizing network, etc. Quantum computing is still in an experimental state, but it has the potential to be a viable alternative to transistor-based microchip computing.

- ii. Neuromorphic Computing: It is an approach to computing based on the structure and function of the human brain. It uses a network of artificial neurons and synapses to compute.
- iii. Alternative Computing Materials: Due to limitation of silicon-based microchip, researchers are exploring dissimilar materials like carbon nanotubes, graphene and spintronics to create more powerful and efficient computing devices.
- iv. Edge Computing: It is an approach to computing that includes processing data on the edge of a network. This reduces the amount of data to be sent, which improves performance and reduces latency.

There are many technologies that can replace Moore's law but amongst them Quantum computing is the most viable alternative which may emerge and last few decades. It has the potential to revolutionize and solve problems with our computers at home.

Week 8 & 9

Assignment 1:

Ans: Keyboard is an input device which allows user to input real-time data to the computer. It is a character-based input device, which means it deals with text, numbers, symbols, etc. It sends an electric signal to the computer's processor when any key is pressed. Then, it is converted into Unicode or ASCII value, one character at a time.

In contrast, Hard disk is a storage device that stores data and program. Data is stored on a hard disk in magnetically encoded digital signals in solid state or on a spinning disk. It can be of any form, including text, images, audio, software or even operating system. Unlike a keyboard, a hard disk stores data until it is required by a computer's processing unit.

In nutshell we can say that, while both a keyboard and a hard disk are input devices, the nature of data they handle is quite different from each other. A keyboard deals with real time input of data in form of text character, numbers, and symbols, while a hard disk stores data in it until required by computer.

Assignment 2:

Ans: Buffer is a region of computer memory where data are temporarily stored while being moved from one place to another. It uses registers or memory to transfer data according to the demand. Every device has its own speed and processing power. The incompatibility in speed between these devices can cause loss of data or corruption in files during the transfer process. To prevent these from happening, buffer is used.

The main purpose of buffer is to enable transfer of data in a smooth, efficient, and reliable way from one end to another. It is used to prevent data loss during the transfer process which may occur due to different transfer rates

between the source and destination computer. As buffer works like a temporary storage device, in case of slow receiving ability of destination computer, it holds the data inside it until the destination is ready to ensures smooth transfer of data without any errors.

In summary, a buffer enables efficient and smooth data transfer by supplying temporary storage in case of need. It helps to prevent any loss of data, improve performance, and enable asynchronous operations.

Assignment 3:

Ans: An interrupt is an event that alters the flow of instruction that is processed by the processor. Computers supply one or more special control lines to the central processor, known as interrupt lines. An interrupt may be planned or unplanned.

When an interrupt occurs, the program currently executing is suspended and transferred to the interrupt handler. Interrupt handler saves all the necessary data of the interrupted program that might be necessary for resuming the operation once the interrupt is handled. Interrupts are an essential feature used for handling users input, hardware events and executing system level services. It enables the processor to handle multiple tasks simultaneously, without wasting processing time.

In conclusion, when an interrupt occurs, the program currently running is stopped and the processing power is transferred to its handler which stores all the necessary information needed for resuming the program.

Assignment 4:

Ans: DMA stands for Direct Memory Access. DMA is a technique of I/O-memory data transfer between the memory and its peripherals without involving CPU.

In a typical system, CPU manages the transfer of data between input/output and memory which is time consuming and inefficient, especially when there is large amount of data to be transferred. To solve this problem DMA was introduced. DMA adds the capability to transfer data directly from peripheral to the memory without

the need of CPU which saves time and increases the speed and performance. It is used in high performance systems where enormous amounts of data are to be transferred, which can significantly be improved by DMA by reducing the overhead on CPU and making the overall system more responsive and efficient.