MANYAM FRANCHISE
Discover!Learn!Apply

COMPUTER STUDIES NOTES

THE CENTRAL PROCESSING UNIT (CPU)

MARCH 3, 2018

MANYAM FRANCHISE
0728 450425

THE CENTRAL PROCESSING UNIT (CPU)

INTRODUCTION

The CPU also known as the processor is mounted on the system board (mother board) inside the system unit. It's regarded as the brain of the computer because it does all the processing activities in the computer.

FIGURE 1: THE CPU (BOTTOM AND TOP VIEW RESPECTIVELY)

PARTS OF THE CENTRAL PROCESSING UNIT

The CPU consist of the three major parts namely:

1. The Control Unit
2. The Main Memory
3. The Arithmetic and logic Unit

1. The Control Unit

The control unit (CU) coordinates all the processing activities in the CPU as well as input, storage and output operations. The CPU uses a system clock to coordinate these activities. The system clock also determines the speed of the CPU. The higher the number of cycles/pulses per second which is also called frequency the faster the CPU.

The CU determines the instruction to be executed, the operation to be performed by the instruction, where the instructions are to be stored and where the next instruction is located.

Clock Speeds

The speed of the CPU is measured in units called **Hertz (Hz),** this is also the unit for measuring frequency. Frequency is the number of cycles per second**.** *If a current completes one cycle per second, then the frequency is 1 Hz; 60 cycles per second equals 60 Hz.* The clock speed determines how many instructions per second the processor can execute. Also called the clock rate, the speed at which a microprocessor executes instructions. Every computer contains an internal clock that regulates the rate at which instructions are executed and synchronizes the various computer components. The CPU requires a fixed number of clock ticks (or cycles) to execute each instruction. The faster the clock, the more the instructions the CPU can execute per second.

CPU SPEED MEASURES

1 hertz or Hz = 1 cycle per second

1 MHz = 1 million cycles per second or 1000 Hz

1 GHz = 1 billion cycles per second or 1000 MHz

Summary of development of microprocessors and their speeds

Year	Name of processor	Clock speeds
1979	8088	8 MHz
1989	80486DX	50 MHz
1999	Pentium III	733 MHz
2003	Pentium IV	2,200 MHz
2009	Intel releases the first Core i5 Desktop processor with 4 cores, the i5-750	2,670 MHz
	AMD releases the first Athlon II X3 (triple core) processors	3,400 MHz
2018	Intel Core i9-7980XE (18 cores)	3,700 MHz - 4,000 MHz
	AMD Ryzen Threadripper 1950X (16 cores)	3,700 MHz – 4,000 MHz

How data moves from input to output

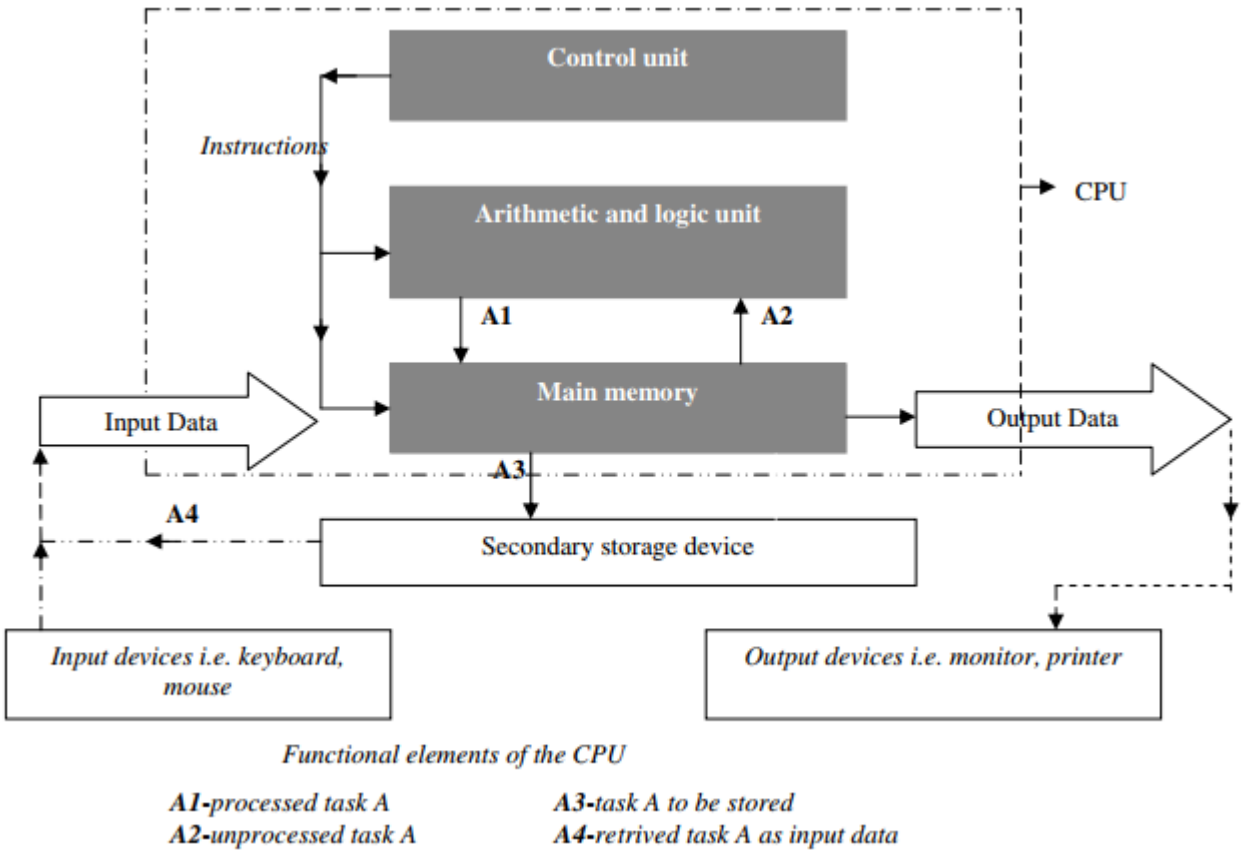

FIGURE 2: MOVEMENT OF DATA FROM INPUT TO OUTPUT

2. The Arithmetic and Logic Unit

This is a unit in the CPU where all the logical and arithmetic operations are carried out. It does this by decoding instructions from the control unit to processes data. Some of the arithmetic operations include: *addition, subtraction, division, multiplication etc. logical operations include: less than, equal to, greater than, sorting, filtering etc.*

The ALU use special devices called **logic gates** to perform arithmetic and logical operations using binary language.

3. The Main Memory

The main memory is also called primary storage. It stores data that is directly accessible by the CPU. The main memory of a computer can be classified as RAM (random access memory) and ROM (read only memory)

a) RAM

Random Access Memory (RAM) is a memory scheme within the computer system responsible for storing data on a temporary basis, so that it can be promptly accessed by the processor as and when needed. It is volatile in nature, which means that data will be erased once supply to the storage device is turned off. RAM stores data randomly and the processor accesses these data randomly from the RAM storage. RAM is considered "random access" because you can access any memory cell directly if you know the row and column that intersect at that cell.

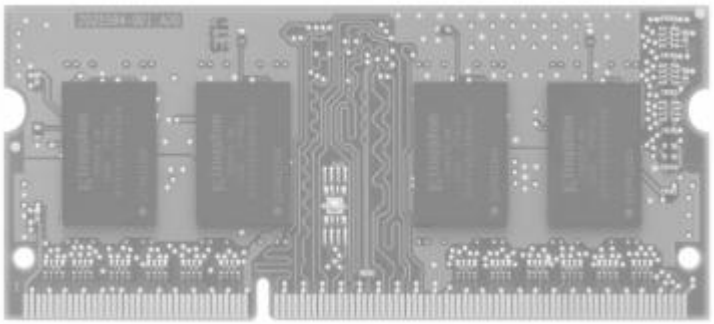

FIGURE 3: THE RAM

Types of RAM

There are two types of RAM namely:

i) **Static RAM**

SRAM (Static RAM) is random access memory (RAM) that retains data bits in its memory as long as power is being supplied.

ii) Dynamic RAM

Dynamic random access memory (DRAM) is the most common kind of random access memory (RAM) for personal computers and workstations. It needs to have its storage cells refreshed or given a new electronic charge every few milliseconds. DRAM stores each bit in a storage cell consisting of a capacitor and a transistor. Capacitors tend to lose their charge and therefore needs to be refreshed.

Differences between the Static RAM and Dynamic RAM

Static RAM	Dynamic RAM
Faster	Slower
Expensive	Cheaper
Does not refresh contents	Refresh contents over time
Less memory per chip	More memory per chip

b) ROM

The ROM is a class of storage medium used in computers and other electronic devices. Data stored in ROM cannot be modified, or can be modified only slowly or with difficulty It is mainly used to distribute firmware (software that is very closely tied to specific hardware and unlikely to need frequent updates)

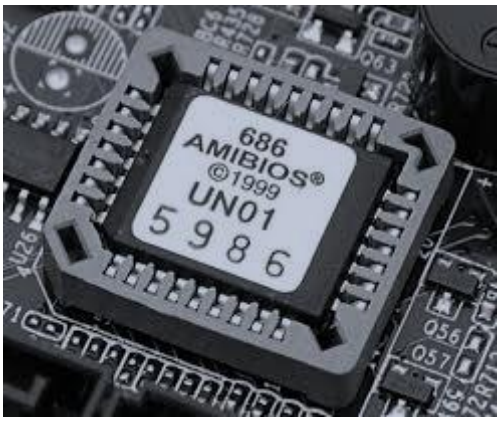

FIGURE 4: ROM

Types of ROM

Type of ROM	Characteristics
Mask ROM	Once the contents have been programmed (written) in it by the manufacturer, they can never be erased.
Programmable ROM (PROM)	This is a read-only memory (ROM) that can be modified once by a user. PROM is a way of allowing a user to tailor a microcode program using a special machine called a PROM programmer. This machine supplies an electrical current to specific cells in the ROM that effectively blows a fuse in them. The process is known as burning the PROM
Erasable Programmable ROM (EPROM)	EPROM can be erased by exposing it to strong ultraviolet light source (such as from a mercury-vapor light). this is done through a transparent fused quartz window in the top of the package
Electrically Erasable Programmable ROM (EEPROM)	This is a user-modifiable read-only memory (ROM) that can be erased and reprogrammed (written to) repeatedly through the application of higher than normal electrical voltage.

Differences between RAM and ROM

RAM	ROM
It's Volatile	It's non-volatile
Stores data temporarily	Stores data temporarily and permanently
It is a read and write memory	It is a read only memory
Contents in the RAM are user defined	Contents in the ROM are manufacturer's settings
Have a high storage capacity	Comparatively, have a lower storage capacity

Virtual Memory

In order to manage memory more efficiently and with fewer errors, modern systems provide an abstraction of main memory known as virtual memory (VM). This is a storage allocation scheme in which secondary memory can be addressed as though it were part of main memory.

The virtual memory is a creation of the operating system and works silently behind the scene. If too many processes need too much memory, then some of them will simply not be able to run. When a program is out of space, it is out of luck. Memory is also vulnerable to corruption. If some process accidentally writes to the memory used by another process, that process might fail or halt.

Functions of the virtual memory

(1) It uses the main memory efficiently by treating it as a cache for an address space stored on disk, keeping only the active areas in main memory, and transferring data back and forth between disk and memory as needed.

(2) It simplifies memory management by providing each process with a uniform address space.

(3) It protects the address space of each process from corruption by other processes.

Special purpose memories

These are types of memories housed in the CPU, system board, input and output devices to enhance performance.

Types of special purpose memories:

These are types of memories housed in the CPU, system board, input and output devices to enhance performance.

Examples of special types of memories:

1. The Cache Memory

A CPU cache is a type of special memory used by the central processing unit of a computer to reduce the average time to access the main memory (RAM). The cache is a smaller, faster memory which stores copies of the data from the most frequently used main memory locations. As the microprocessor

processes data, it looks first in the cache memory and if it finds the data there (from a previous reading of data), it does not have to do the more time-consuming reading of data from larger memory (RAM). Cache memory is sometimes described in levels of closeness and accessibility to the microprocessor. An ***L1*** cache for example is on the same chip as the microprocessor.

2. Buffers

A buffer is a region of physical memory storage used to temporarily hold data while it is being moved from one place to another. Typically, the data is stored in a buffer as it is retrieved from an input device (such as a mouse) or just before it is sent to an output device (such as speakers). However, a buffer may be used when moving data between processes within a computer. Like a cache, a buffer is a "midpoint holding place" but exist not so much to accelerate the speed of an activity as to support the coordination of separate activities.

3. Registers

A processor register is a small amount of storage available as part of a CPU or other digital processor. Such registers are (typically) addressed by mechanisms other than main memory and can be accessed more quickly. Almost all computers, load-store architecture or not, load data from a larger memory into registers where it is used for arithmetic, manipulated, or tested, by some machine instruction. Manipulated data is then often stored back in main memory, either by the same instruction or a subsequent one.

Types of Registers

1. **Accumulator**

An accumulator is a register for short-term, intermediate storage of arithmetic and logic data in a computer's CPU (central processing unit).

2. **Instruction Register**

Instructions register (IR) is used to store the instruction currently being executed or decoded.

3. Address Register

The Memory Address Register (MAR) is a CPU register that either stores the memory address from which data will be fetched to the CPU or the address to which data will be sent and stored.

4. Storage Register

Holds a piece of data that is on its way to and from the CPU and the main memory.

Memory capacities

The SI unit for measuring memory and storage capacity is called a **byte**. A byte is a single character which can either be 0, 9, a, z, symbols like / and : and spaces.

Memory quantities can be expressed in:

Byte	approx.	8-bits
Kilobyte (KB)	approx.	1000 bytes (real units are 1024 bytes)
Megabyte (MB)	approx.	10^6 bytes
Gigabyte (GB)	approx.	10^9 bytes
Terabytes	approx.	10^{12} bytes

Larger memory quantities are:-

Petabyte	approx.	10^{15} bytes
Exabyte	approx.	10^{18} bytes
Zettabyte	approx.	10^{21} bytes
Yottabyte	approx.	10^{24} bytes
Xenottabyte	approx.	10^{27} bytes
Shilentnobyte	approx.	10^{30} bytes
Domegemegrottebyte	approx.	10^{33} bytes

Types of Processors

Processors can be of different types depending on the technology used to manufacture them, manufacturer and ISA – Instruction Set Architecture

Types of processors according to ISA

There two types of processors according to ISA; Namely:

- CISC – Complex Instruction Set Computers
- RISC – Reduced Instruction Set Computers

1. *CISC – Complex Instruction Set Computers*

CISC has the ability to execute addressing modes or multi-step operations within one instruction set. It is the design of the CPU where one instruction performs many low-level operations. For example, memory storage, an arithmetic operation and loading from memory. Computers based on the CISC architecture are designed to decrease the memory cost. Because, the large programs need more storage, thus increasing the memory cost and large memory becomes more expensive. To solve these problems, the number of instructions per program can be reduced by embedding the number of operations in a single instruction, thereby making the instructions more complex.

2. *RISC – Reduced Instruction Set Computers*

RISC is a type of microprocessor architecture that uses highly-optimized set of instructions. RISC does the opposite, reducing the cycles per instruction at the cost of the number of instructions per program Pipelining is one of the unique feature of RISC. It is performed by overlapping the execution of several instructions in a pipeline fashion. RISC is a CPU design strategy based on the insight that simplified instruction set gives higher performance when combined with a microprocessor architecture which has the ability to execute the instructions by using some microprocessor cycles per instruction. RISC (Reduced Instruction Set Computer) is used in portable devices due to its power efficiency.

Questions on Topic

1. The brain of a personal computer is called?
2. Name the three parts that make up the CPU
3. The speed of a computer is measured in?
4. A_____ provides power to the system clock when the computer is turned off.
5. Explain the meaning of the following terms:
    a. RISC
    b. CISC
    c. Microprocessor
    d. Virtual Memory
    e. ROM
    f. RAM
    g. Hertz
    h. A byte
    i. Cache memory
    j. Buffer
6. List the three types of address register and state their functions
7. A group of 8-bits is called?
8. A megabyte is equal to _____ bytes
9. The word bit means?
10. How many bytes would be required to store the following statement:

    “my votes were stolen.” Says Raila

11. Describe the two types of RAM.
12. Differentiate between the RAM and the ROM.
13. Describe the different types of ROM.
14. Differentiate between static Ram and Dynamic RAM

15. Describe memory registers and give the four examples of register and their uses.
16. What is the difference between the control unit and the arithmetic and logic unit?
17. How does a computer memory differ from a human memory?
18. Give two facts about the system clock.
19. Explain the following words:
    a. Instruction set
    b. Frequency
    c. Bandwidth
20. Nyambu bought an 8GB flash disk to save her favorite MP_3 music. If each music track had an average of 2MB. How many tracks will she save in her disk?
21. When a computer realizes that the amount of memory available for processing is less than what is required, what does the operating system do?
22. Why does the RISC architecture preferred for portable devices?
23. Oongo sent the work he was typing to the printer, but mistakenly closed the document he was typing on the screen but the printer still continued printing the entire document without failure. Explain why the printer still persisted to print despite the closing of the document.
24. Write a computer essay about **"Development of the CPU since 1979".** The essay should not exceed 730 words.

Works Cited

Agarwal, T. (2015, 02 19). *What is RISC and CISC Architecture ?* Retrieved from Edgefxkits: http://www.edgefxkits.com/blog/what-is-risc-and-cisc-architecture/

Carey, G. (2018, Feb. 27). *Best processors 2018: top CPUs for your PC*. Retrieved from Techradar: https://www.techradar.com/news/best-processors

Differences, T. (2017, Jan 23). *Difference Between RAM and ROM Memory*. Retrieved from Tech Differences: https://techdifferences.com/difference-between-ram-and-rom-memory.html

highscalability. (2012, Sept. 11). *How big is a Petabyte, Exabyte, Zettabyte, or Yottabyte?* Retrieved from High Scalability: http://highscalability.com/blog/2012/9/11/how-big-is-a-petabyte-exabyte-zettabyte-or-a-yottabyte.html

Hope, C. (2017, May 05). *Computer processor history*. Retrieved from Computer Hope: https://www.computerhope.com/history/processor.htm

http://csapp.cs.cmu.edu. (n.d.). *Virtual Memory.* Retrieved from http://csapp.cs.cmu.edu/2e/ch9-preview.pdf

http://www.just.edu.jo/. (n.d.). *Introduction to Computer.* Retrieved from just.edu: http://www.just.edu.jo/~mqais/CIS99/PDF/Ch.01_Introduction_%20to_computers.pdf

Mburu, s., & Chemwa, G. (2004). LONGHORN SECONDARY COMPUTER STUDIES FORM 1. In s. Mburu, & G. Chemwa, *LONGHORN SECONDARY COMPUTER STUDIES FORM 1* (pp. 41-48). Nairobi: LONGHORN PUBLISHERS.

Onunga, D. J., & Renu , S. (2003). KCSE COMPUTER STUDIES BOOK 1. In D. J. Shah, *KCSE COMPUTER STUDIES BOOK 1* (pp. 48-64). Nairobi: Mariwa Publishers.