UNIT – I

Functional blocks of a computer: CPU, memory, input-output subsystems, control unit. Computer Organization and Architecture - Von Neumann
Data representation: signed number representation, fixed and floating point Representations, Character representation. Computer arithmetic – integer addition and Subtraction, Ripple carry adder, carry look-ahead adder, etc. Multiplication – shift-and add, Booth multiplier, Carry save multiplier, etc. Division restoring and non-restoring techniques, Floating point arithmetic

Functional Units

A computer consists of five functionally independent main parts: input, memory, arithmetic and logic, output, and control units, as shown in Figure 1.1.

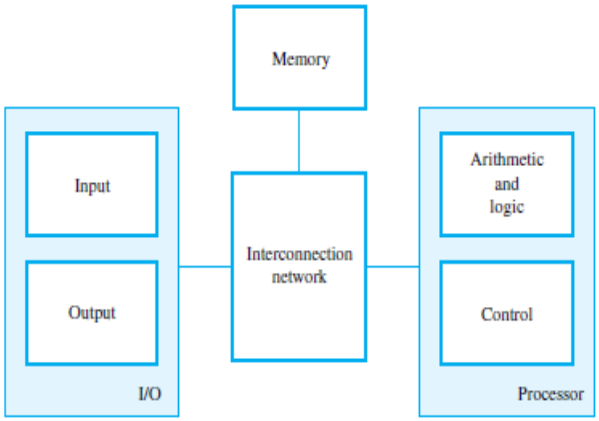

Figure 1.1 Basic functional units of a computer.

The input unit accepts coded information from human operators using devices such as keyboards, or from other computers over digital communication lines. The information received is stored in the computer's memory, either for later use or to be processed immediately by the arithmetic and logic unit. The processing steps are specified by a program that is also stored in the memory. Finally, the results are sent back to the outside world through the output unit. All of these actions are coordinated by the control unit. An interconnection network provides the means for the functional units to exchange information and coordinate their actions. The arithmetic and logic circuits, in conjunction with the main control circuits, is the processor. Input and output equipment is often collectively referred to as the input-output (I/O) unit.

A program is a list of instructions which performs a task. Programs are stored in the memory. The processor fetches the program instructions from the memory, one after another, and performs the desired operations. The computer is controlled by the stored program, except for possible external interruption by an operator or by I/O devices connected to it. Data are numbers and characters that are used as operands by the instructions. Data are also stored in the memory. The instructions and data handled by a computer must be encoded in a suitable format. Each instruction, number, or character is encoded as a string of binary digits called bits, each having one of two possible values, 0 or 1, represented by the two stable states.

Input Unit

Computers accept coded information through input units. The most common input device is the keyboard. Whenever a key is pressed, the corresponding letter or digit is automatically translated into its corresponding binary code and transmitted to the processor.

Many other kinds of input devices for human-computer interaction are available, including the touchpad, mouse, joystick, and trackball. These are often used as graphic input devices in conjunction with displays.

Microphones can be used to capture audio input which is then sampled and converted into digital codes for storage and processing.

Similarly, cameras can be used to capture video input.

Digital communication facilities, such as the Internet, can also provide input to a computer from other computers and database servers.

Memory Unit

The function of the memory unit is to store programs and data. There are two classes of storage, called primary and secondary.

Primary Memory

Primary memory, also called main memory, is a fast memory that operates at electronic speeds. Programs must be stored in this memory while they are being executed. The memory consists of a large number of semiconductor storage cells, each capable of storing one bit of information. These cells are rarely read or written individually.

Instead, they are handled in groups of fixed size called words. The memory is organized so that one word can be stored or retrieved in one basic operation. The number of bits in each word is referred to as the word length of the computer, typically 16, 32, or 64 bits.

To provide easy access to any word in the memory, a distinct address is associated with each word location. Addresses are consecutive numbers, starting from 0, that identify successive locations.

Instructions and data can be written into or read from the memory under the control of the processor. A memory in which any location can be accessed in a short and fixed amount of time after specifying its address is called a random-access memory (RAM). The time required to access one word is called the memory access time. This time is independent of the location of the word being accessed. It typically ranges from a few nanoseconds (ns) to about 100 ns for current RAM units

Cache Memory

As an adjunct to the main memory, a smaller, faster RAM unit, called a cache, is used to hold sections of a program that are currently being executed, along with any associated data. The cache is tightly coupled with the processor and is usually contained on the same integrated-circuit chip. The purpose of the cache is to facilitate high instruction execution rates.

At the start of program execution, the cache is empty. As execution proceeds, instructions are fetched into the processor chip, and a copy of each is placed in the cache. When the execution of an instruction requires data, located in the main memory, the data are fetched and copies are also placed in the cache. If these instructions are available in the cache, they can be fetched quickly during the period of repeated use.

Secondary Storage

Although primary memory is essential, it tends to be expensive and does not retain information when power is turned off. Thus additional, less expensive, permanent secondarystorage is used when large amounts of data and many programs have to be stored, particularly for information that is accessed infrequently. Access times for secondary storage are longer than for primary memory. The devices available are including magnetic disks, optical disks (DVD and CD), and flash memory devices.