**Unit 16**

**PROGRAMMING LANGUAGES**

**AIM:**

To recognize the English technical terms related to programming languages;

**OBJECTIVES:**

On successfully completing this unit the student should be able to:

* identify correctly the terms defining categories of programming languages;
* recognise the specific terms related to machine language description;
* characterise assembly language;
* identify the types of high-level languages currently in use;
* describe the development of the first programming languages;
* assimilate at least 30 terms specific of programming languages;

**KEY TERMS:**

*programming language, software, software, machine code, code, computer operating system, executables, executable program, machine code, , Intel Pentium Power microprocessor chip, machine code instruction, register, strings of 0s and 1s, assembly language, high-level language, easy-to-remember command, machine-language command, equivalent command, statement, assembly-language program, assembler, series of abstract codes, high-level language program, command, CPU-specific, high-level C++ programming language, cryptic statement, “standard output”, compiler, Java, FLOW-MATIC, bug, computer malfunction, computer error, International Business Machines, Inc. (IBM), Fortran (Formula Translation), BASIC (Beginner’s All-purpose Symbolic Instruction Code), the sequence of the commands, to prompt.*

**PROGRAMMING LANGUAGES**

**16.1. INTRODUCTION**

Programming languages contain the series of commands that create software. A CPU has a limited set of instructions known as machine code that it is capable of understanding. The CPU can understand only this language. All other programming languages must be converted to machine code for them to be understood. Computer programmers, however, prefer to use other computer languages that use terms or other commands because they are easier to use. These other languages are slower because the language must be translated first so that the computer can understand it. The translation can lead to code that may be less efficient to run

than code written directly in the machine’s language.

**16.1.1 Machine Language**

Computer programs that can be run by a computer’s operating system are called executables. An executable program is a sequence of extremely simple instructions known as machine code. These instructions are specific to the individual computer’s CPU and associated hardware; for example, Intel Pentium and Power PC microprocessor chips each have different machine languages and require different sets of codes to perform the same task. Machine code instructions are few in number (roughly 20 to 200, depending on the computer and the CPU). Typical instructions are for copying data from a memory location or for adding the contents of two memory locations (usually registers in the CPU). Complex tasks require a sequence of these simple instructions. Machine code instructions are binary—that is, sequences of bits (0s and 1s). Because these sequences are long strings of 0s and 1s and are usually not easy to understand, computer instructions usually are not written in machine code. Instead, computer programmers write code in languages known as an assembly language or a high-level language.

**16.1.2. Assembly Language**

Assembly language uses easy-to-remember commands that are more understandable to programmers than machine-language commands. Each machine language instruction has an equivalent command in assembly language. For example, in one Intel assembly language, the statement “MOV A, B” instructs the computer to copy data from location A to location B. The same instruction in machine code is a string of 16 0s and 1s. Once an assembly-language program is written, it is converted to a machine-language program by another program called an assembler.

Assembly language is fast and powerful because of its correspondence with machine language. It is still difficult to use, however, because assembly-language instructions are a series of abstract codes and each instruction carries out a relatively simple task. In addition, different CPUs use different machine languages and therefore require different programs and different assembly languages. Assembly language is sometimes inserted into a high-level language program to carry out specific hardware tasks or to speed up parts of the high-level program that are executed frequently.

**16.1.3. High-Level Languages**

High-level languages were developed because of the difficulty of programming using assembly languages. High-level languages are easier to use than machine and assembly languages because their commands are closer to natural human language. In addition, these languages are not CPU-specific. Instead, they contain general commands that work on different CPUs. For example, a programmer writing in the high-level C++ programming language who wants to display a greeting need include only the following command:   
**cout << ‘Hello, !’ << endl;**

This command directs the computer’s CPU to display the greeting, and it will work no matter what type of CPU the computer uses. When this statement is executed, the text that appears between the quotes will be displayed. Although the “cout” and “endl” parts of the above statement appear cryptic, programmers quickly become accustomed to their meanings. For example, “cout” sends the greeting message to the “standard output” (usually the computer user’s screen) and “endl” is how to tell the computer (when using the C++ language) to go to a new line after it outputs the message. Like assembly-language instructions, high-level languages also must be translated. This is the task of a special program called a compiler. A compiler turns a high-level program into a CPU-specific machine language. For example, a programmer may write a program in a high-level language such as C++ or Java and then prepare it for different machines, such as a Sun Microsystems work station or a personal computer (PC), using compilers designed for those machines. This simplifies the programmer’s task and makes the software more portable to different users and machines.

**16.2. FLOW-MATIC**

American naval officer and mathematician Grace Murray Hopper helped develop the first commercially available high-level software language, FLOW-MATIC, in 1957. Hopper is credited for inventing the term bug, which indicates a computer malfunction; in 1945 she discovered a hardware failure in the Mark II computer caused by a moth trapped between its mechanical relays. She documented the event in her laboratory notebook, and the term eventually came to represent any computer error, including one based strictly on incorrect instructions in software. Hopper taped the moth into her notebook and wrote, “First actual case of a bug being found.”

**16.3. Fortran**

From 1954 to 1958 American computer scientist John Backus of International Business Machines, Inc. (IBM) developed Fortran, an acronym for *For*mula *Trans*lation. It became a standard programming language because it could process mathematical formulas. Fortran and its variations are still in use today, especially in physics.

**16.4. BASIC**

Hungarian-American mathematician John Kemeny and American mathematician Thomas Kurtz at Dartmouth College in Hanover, New Hampshire, developed BASIC (*B*eginner’s *A*ll-purpose *S*ymbolic *I*nstruction *C*ode) in 1964. The language was easier to learn than its predecessors and became popular due to its friendly, interactive nature and its inclusion on early personal computers. Unlike languages that require all their instructions to be translated into machine code first, BASIC is turned into machine language line by line as the program runs. BASIC commands typify high-level languages because of their simplicity and their closeness to natural human language. For example, a program that divides a number in half

can be written as   
**10 INPUT “ENTER A NUMBER,” X**   
**20 Y=X/2**   
**30 PRINT “HALF OF THAT NUMBER IS,” Y**  
The numbers that precede each line are chosen by the programmer to indicate the sequence of the commands. The first line prints “ENTER A NUMBER” on the computer screen followed by a question mark to prompt the user to type in the number labelled “X.” In the next line, that number is divided by two and stored as “Y.” In the third line, the result of the operation is displayed on the computer screen. Even though BASIC is rarely used today, this simple program demonstrates how data are stored and manipulated in most high-level programming languages.

BD18217_ **You may want to go back to the key words listed at the beginning of the unit and check that you are familiar with each one. Give their Romanian equivalents (if necessary, you can use the glossary provided at the end of the textbook).**

**EXERCISES**

**A. READING**

**The purpose of the following exercises is to develop reading strategies and reinforce topic related vocabulary, not to check background knowledge.**

**A.1. Having read the text, answer the following questions (the specifications in brackets refer to the section in the text where the answer can be found):**

1. What is a machine language?

2. What is the set of instructions like with machine codes?

3. What is an assembly language?

4. What is the difference between machine language and assembly language?

5. What are the instructions like in assembly language?

6. What are high-level languages?

7. Why were high-level languages developed?

8. What are the instructions like in high level language?

9. What is used for the translation of high-level language program instructions?

10. What are t6he advantages of high level languages?

**A.2. Having read the text, decide whether the information given in the statements below is true (T) or false (F). Correct the false statements (the specifications in brackets refer o the section in the text where the answer can be found):**

1. An executable program is a sequence of extremely complex instructions known as machine code. (16.1.1.)

2. Intel Pentium and Power PC microprocessor chips each have different machine languages and require different sets of codes to perform the same task. (16.1.1.)

3. Because these sequences are long strings of 0s and 1s and are usually easy to understand, computer instructions usually are written in machine code. (16.1.1.)

4. Computer programmers write code in languages known as an assembly language or a high-level language. (16.1.2.)

5. Each machine language instruction has an equivalent command in assembly language.

6. Once an assembly-language program is written, it is converted to a machine-language program by another program called a compiler. (16.1.2.)

7.CPUs use the same machine language and therefore do not require different programs and different assembly languages. (16.1.2.)

8. High-level languages are easier to use than machine and assembly languages because their commands are closer to natural human language. (16.1.3.)

9. A programmer may write a program in a high-level language such as C++ or Java and then prepare it for different machines, such as a Sun Microsystems work station or a personal computer (PC), using assemblers designed for those machines. (16.1.3.)

10. Unlike languages that require all their instructions to be translated into machine code first, BASIC is turned into machine language line by line as the program runs. (16.4.)

**B. VOCABULARY WORK**

**The purpose of the following exercises is to promote the acquisition of new lexical items by providing collocations, terms followed by prepositions lexical sets and translations of the terms considered relevant to the topic.**

**B.1. Enter in the following table information related to programming languages:**

**Table 16.1.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Type of programming language** | **Instruction code** | **Special uses** | **Example of instruction set** | **Conversion into** | **Conversion by means of** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**B.2. Fill in the missing terms:**

1. From 1954 to 1958 American computer scientist John Backus of\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, Inc. (IBM) developed Fortran, an acronym for\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. Fortran became a standard programming language because it could process\_\_\_\_\_\_\_\_\_.

3. Hopper is credited for inventing the term bug, which indicates a computer\_\_\_\_\_\_\_; in 1945 she discovered a \_\_\_\_\_\_\_\_\_\_\_in the Mark II computer caused by a moth trapped between its mechanical\_\_\_\_\_\_\_\_\_\_\_.

**C. LANGUAGE FOCUS: LINKING DEVICES**

**The purpose of the following exercises is to develop language awareness in terms of text cohesion by making explicit the relation between sentences.**

**C.1. Text cohesion is normally achieved by means of linking device that are making the relation between sentences explicit. Find the linking devices in the text below and identify to the type of relation they reflect.**

1. High-level languages are easier to use than machine and assembly languages because their commands are closer to natural human language. In addition, these languages are not CPU-specific. Instead, they contain general commands that work on different CPUs. For example, a programmer writing in the high-level C++ programming language who wants to display a greeting need include only the following command:   
   **cout << ‘Hello, !’ << endl;**
2. When this statement is executed, the text that appears between the quotes will be displayed. Although the “cout” and “endl” parts of the above statement appear cryptic, programmers quickly become accustomed to their meanings. For example, “cout” sends the greeting message to the “standard output” (usually the computer user’s screen) and “endl” is how to tell the computer (when using the C++ language) to go to a new line after it outputs the message.
3. It is still difficult to use, however, because assembly-language instructions are a series of abstract codes and each instruction carries out a relatively simple task. In addition, different CPUs use different machine languages and therefore require different programs and different assembly languages.

**C.2. Write at least ten other linking elements and identify the type of relation they reflect.**

**D. TRANSLATION**

**The purpose of this exercise is to develop translating skills.**

**D.1.Translate the following text into Romanian:**

For example, a programmer writing in the high-level C++ programming language who wants to display a greeting need include only the following command:   
**cout << ‘Hello, !’ << endl;**

This command directs the computer’s CPU to display the greeting, and it will work no matter what type of CPU the computer uses. When this statement is executed, the text that appears between the quotes will be displayed. Although the “cout” and “endl” parts of the above statement appear cryptic, programmers quickly become accustomed to their meanings. For example, “cout” sends the greeting message to the “standard output” (usually the computer user’s screen) and “endl” is how to tell the computer (when using the C++ language) to go to a new line after it outputs the message.

**E. SPEAKING**

**The purpose of these exercises is to develop speaking skills with a focus on comparing the features of the different types of programming languages in parallel.**

**E.1. Compare the three types of programming languages in point of: type of code used for programming, difficulty of commands, necessity of conversion, advantage.**

**Unit 17**

**SEMICONDUCTORS**

**AIM:**

To recognize the English technical terms related to semiconductors and semiconductor technology;

**OBJECTIVES:**

On successfully completing this unit the student should be able to:

* identify correctly the terms defining semiconductor types, features, applications;
* recognise the specific terms related to the functions provided by semiconductors;
* describe the procedure of semiconductor doping and its results;

* identify the types of devices using semiconductor technology;
* describe the internal structure of semi conducting materials;
* assimilate at least 30 terms specific of semiconductor structure, features and applications;

**KEY TERMS:**

*semiconductor, conduct, insulator, electrical conductivity, voltage, physical property, copper, silver, diamond, glass, poor conductors, aluminium, pure semiconductor, addition of impurities, solid-state physics, chemical element, chemical compound, silicon, germanium, selenium, gallium arsenide, zinc selenide, lead telluride, conduction electron, pure/ intrinsic semiconductor, valence electron, outer electron, atom, covalent bond, crystal, “holes”, energy gap, free carriers of electricity, “dope”, doping material, dopant, donors / acceptors of electrons, negative (n-type) / positive (p-type) carriers of electricity, doped silicon (Si) crystal, phosphorus (P), deficiency/lack of electrons, adjacent, semiconductor diode, region of contact, p-n junction, two-terminal device, high resistance, low resistance, solar cells, p-n junction laser, rectifier, transistor, complementary metal-oxide semiconductor circuitry( CMOS), technique of molecular-beam epitaxy.*

**SEMICONDUCTORS**

**17.1 INTRODUCTION**

Semiconductor, solid or liquid material, able to conduct electricity at room temperature more readily than an insulator, but less easily than a metal. Electrical conductivity, which is the ability to conduct electrical current under the application of a voltage, has one of the widest ranges of values of any physical property of matter. Such metals as copper, silver, and aluminium are excellent conductors, but such insulators as diamond and glass are very poor conductors. At low temperatures, pure semiconductors behave like insulators. Under higher temperatures or light or with the addition of impurities, however, the conductivity of semiconductors can be increased dramatically, reaching levels that may approach those of metals. The physical properties of semiconductors are studied in solid-state physics.

**17.2. Conduction Electrons and Holes**

The common semiconductors include chemical elements and compounds such as silicon, germanium; selenium, gallium arsenide, zinc selenide, and lead telluride. The increase in conductivity with temperature, light, or impurities arises from an increase in the number of conduction electrons, which are the carriers of the electrical current. In a pure, or intrinsic, semiconductor such as silicon, the valence electrons, or outer electrons, of an atom are paired and shared between atoms to make a covalent bond that holds the crystal together. These valence electrons are not free to carry electrical current. To produce conduction electrons, temperature or light is used to excite the valence electrons out of their bonds, leaving them free to conduct current. Deficiencies, or “holes,” are left behind that contribute to the flow of electricity. (These holes are said to be carriers of positive electricity.) This is the physical origin of the increase in the electrical conductivity of semiconductors with temperature. The energy required to excite the electron and hole is called the energy gap.

**17.3 Doping**

Another method to produce free carriers of electricity is to add impurities to, or to “dope,” the semiconductor. The difference in the number of valence electrons between the doping material, or dopant (either donors or acceptors of electrons), and host gives rise to negative (n-type) or positive (p-type) carriers of electricity. This concept is illustrated in the accompanying diagram of a doped silicon (Si) crystal. Each silicon atom has four valence electrons (represented by dots); two are required to form a covalent bond. In n- type silicon, atoms such as phosphorus (P) with five valence electrons replace some silicon and provide extra negative electrons. In p-type silicon, atoms with three valence electrons such as aluminium (Al) lead to a deficiency of electrons, or to holes, which act as positive electrons. The extra electrons or holes can conduct electricity.

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| --- |
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When p-type and n-type semiconductor regions are adjacent to each other, they form a semiconductor diode, and the region of contact is called a p-n junction. (A diode is a two-terminal device that has a high resistance to electric current in one direction but a low resistance in the other direction.) The conductance properties of the p-n junction depend on the direction of the voltage, which can, in turn, be used to control the electrical nature of the device. Series of such junctions are used to make transistors and other semiconductor devices such as solar cells, p-n junction lasers, rectifiers, and many others.

Semiconductor devices have many varied applications in electrical engineering. Recent engineering developments have yielded small semiconductor chips containing hundreds of thousands of transistors. These chips have made possible great miniaturization of electronic devices. More efficient use of such chips has been developed through what is called complementary metal-oxide semiconductor circuitry, or CMOS, which consists of pairs of p- and n-channel transistors controlled by a single circuit. In addition, extremely small devices are being made using the technique of molecular-beam epitaxy.

BD18217_ **You may want to go back to the key words listed at the beginning of the unit and check that you are familiar with each one. Give their Romanian equivalents (if necessary, you can use the glossary provided at the end of the textbook).**

**EXERCISES**

**A. READING**

**The purpose of the following exercises is to develop reading strategies and reinforce topic related vocabulary, not to check background knowledge.**

**A.1. Having read the text, answer the following questions (the specifications in brackets refer to the section in the text where the answer can be found):**

1. What is the term referring to the ability to conduct electrical current under the application of a voltage? (17.1.)

2. What is a semiconductor? (17.1.)

3. What are the means of increasing the conductivity of semiconductors? (17.1.)

4. What are conduction electrons? (17.2)

5. What is semiconductor doping? (17.3.)

6. What is CMOS? (17.3.)

**A.2. The doping procedure and properties of semiconductors are described in section 17.3. of the text . Sum up the information in 5 sentences, explaining the applications that the hereby acquired properties are most suitable for.**

**B. VOCABULARY WORK**

**The purpose of the following exercises is to promote the acquisition of new lexical items by providing collocations, terms followed by prepositions lexical sets and translations of the terms considered relevant to the topic.**

**B.1. Match each of the terms in column A with a word in column B:**

**A B**

conductivity high

range covalent

conductor intrinsic

physics low

compounds energy

electron wide

semiconductor solid-state

electrons doped

bond valence

gap molecular-beam

silicon conduction

resistance chemical

resistance poor

epitaxy electrical

**B.2. In each series of four terms given below there is one term that does not belong in the series. Underline the ‘odd’ word and justify your decision by finding a suitable noun phrase as a title, as shown in the following example:**

**e.g.: copper, silver, glass, aluminium; - EXCELLENT CONDUCTORS**

1. low temperature, high temperature, addition of impurities, light;

2. silicon, zinc selenide, gallium arsenide, lead telluride;

3. solar cells, p-n junction lasers, electrical conductivity, rectifiers;

**C. LANGUAGE FOCUS**

**The purpose of the following exercises is to develop language awareness in terms of ways of adding information by means of COMPLEX NOUN PHRASES with one or several determinants.**

**C.1. Find in the text five further examples of noun phrases with the following pattern:**

**[ARTICLE+ DETERMINANT+ HEAD of NOUN PHRASE]**

**C.2. Identify corresponding terms denoting features of the following terms and build complex noun phrases for each, using the given nouns as heads of the noun phrase.**

1. circuitry

2. junction

3. conductor

4. bond.

5. cell

**D. TRANSLATION**

**The purpose of this exercise is to develop translating skills.**

**D.1. Translate the noun phrases in B.1. into Romanian and identify the difference regarding the position of the head of the noun phrase and its determinant.**

**D.2. Translate the following terms into Romanian.**

conduction electron, pure/ intrinsic semiconductor, valence electron, outer electron, atom, covalent bond, crystal, energy gap, free carriers of electricity, doping material, dopant, donors / acceptors of electrons, negative (n-type) / positive (p-type) carriers of electricity, doped silicon (Si) crystal, phosphorus (P), deficiency/lack of electrons, semiconductor diode, region of contact, p-n junction, two-terminal device, high resistance, low resistance, p-n junction laser, rectifier, transistor, complementary metal-oxide semiconductor circuitry( CMOS).

**E. SPEAKING**

**The purpose of these exercises is to develop speaking skills with a focus on describing the doping procedure and the effects aimed at.**

**E.1. Describe the doping procedure and the effects aimed at and present it to the class.**

**Unit 18**

**HARDWARE**

**AIM:**

To recognize the English technical terms related to computer hardware;

**OBJECTIVES:**

On successfully completing this unit the student should be able to:

* identify correctly the terms defining the terms defining different hardware categories;
* recognise the specific terms related to each category of equipment;
* characterise the separate components grouping them according to the functions they provide: input hardware, output hardware, storage hardware and hardware connections;
* identify the types of equipment used for data input, data output and data storage
* describe parameters specific to each component;
* assimilate at least 30 terms specific of computer hardware;

**KEY TERMS:**

*hardware, input hardware, output hardware, storage hardware, connect, microprocessors, electronic circuitry, bus, to manipulate data, storage device, Basic Input Output System software (BIOS), firmware, external devices, stylus, light sensitive tip, light pen, light sensors, pointing device, mouse, detection device, on-screen pointer, cursor, joystick, pointing device, lever, keyboard, typewriter-like device, special function keys, integrated pointing devices, trackball, touch-sensitive regions, optical scanner, light-sensing equipment, flatbed scanner, office photocopier, handheld scanner, microphone, modem, modulator-demodulator, digital signal, analogue signal, telephone lines, television cables, receiving modem, external devices, to transfer information, to convert information, to generate information, visual information, display, video screen with a cathode ray tube (CRT), video screen with a liquid crystal display (LCD), CRT-based screen, monitor, LCD-based screen, laptop computers, printer, dot-matrix printers, inked ribbon, laser printers, beams of light, drum, toner, inkjet printers, disk drive, memory, hard disk drive, floppy disk drive, magneto-optical disk drive, compact disk drive, magnetic particle, removable discs, CD-ROM, digital video disc (DVD), retrieval, channels, address bus, data bus, bus width, serial connection, parallel connection, blocks of information,*

**HARDWARE**

**18.1. INTRODUCTION**

Hardware (computer), equipment involved in the function of a computer. Computer hardware consists of the components that can be physically handled. The function of these components is typically divided into three main categories: input, output, and storage. Components in these categories connect to microprocessors, specifically, the computer's central processing unit (CPU), the electronic circuitry that provides the computational ability and control of the computer, via wires or circuitry called a bus.

Software, on the other hand, is the set of instructions a computer uses to manipulate data, such as a word-processing program or a video game. These programs are usually stored and transferred via the computer's hardware to and from the CPU. Software also governs how the hardware is utilized; for example, how information is retrieved from a storage device. The interaction between the input and output hardware is controlled by software called the Basic Input Output System software (BIOS).

Although microprocessors are still technically considered to be hardware, portions of their function are also associated with computer software. Since microprocessors have both hardware and software aspects they are therefore often referred to as firmware.

**18.2. Input Hardware**

Input hardware consists of external devices—that is, components outside of the computer's CPU—that provide information and instructions to the computer. A light pen is a stylus with a light sensitive tip that is used to draw directly on a computer's video screen or to select information on the screen by pressing a clip in the light pen or by pressing the light pen against the surface of the screen. The pen contains light sensors that identify which portion of the screen it is passed over. A mouse is a pointing device designed to be gripped by one hand. It has a detection device (usually a ball) on the bottom that enables the user to control the motion of an on-screen pointer, or cursor, by moving the mouse on a flat surface. As the device moves across the surface, the cursor moves across the screen. To select items or choose commands on the screen, the user presses a button on the mouse. A joystick is a pointing device composed of a lever that moves in multiple directions to navigate a cursor or other graphical object on a computer screen. A keyboard is a typewriter-like device that allows the user to type in text and commands to the computer. Some keyboards have special function keys or integrated pointing devices, such as a trackball or touch-sensitive regions that let the user's finger motions move an on-screen cursor.

An optical scanner uses light-sensing equipment to convert images such as a picture or text into electronic signals that can be manipulated by a computer. For example, a photograph can be scanned into a computer and then included in a text document created on that computer. The two most common scanner types are the flatbed scanner, which is similar to an office photocopier, and the handheld scanner, which is passed manually across the image to be processed. A microphone is a device for converting sound into signals that can then be stored, manipulated, and played back by the computer. A voice recognition module is a device that converts spoken terms into information that the computer can recognize and process.

A modem, which stands for *mod*ulator*-dem*odulator, is a device that connects a computer to a telephone line or cable television network and allows information to be transmitted to or received from another computer. Each computer that sends or receives information must be connected to a modem. The digital signal sent from one computer is converted by the modem into an analogue signal, which is then transmitted by telephone lines or television cables to the receiving modem, which converts the signal back into a digital signal that the receiving computer can understand.

**18.3. Output Hardware**

Output hardware consists of external devices that transfer information from the computer's CPU to the computer user. A video display, or screen, converts information generated by the computer into visual information. Displays commonly take one of two forms: a video screen with a cathode ray tube (CRT) or a video screen with a liquid crystal display (LCD). A CRT-based screen, or monitor, looks similar to a television set. Information from the CPU is displayed using a beam of electrons that scans a phosphorescent surface that emits light and creates images. An LCD-based screen displays visual information on a flatter and smaller screen than a CRT-based video monitor. LCDs are frequently used in laptop computers.

Printers take text and image from a computer and print them on paper. Dot-matrix printers use tiny wires to impact upon an inked ribbon to form characters. Laser printers employ beams of light to draw images on a drum that then picks up fine black particles called toner. The toner is fused to a page to produce an image. Inkjet printers fire droplets of ink onto a page to form characters and pictures.

**18.4. Storage Hardware**

Storage hardware provides permanent storage of information and programs for retrieval by the computer. The two main types of storage devices are disk drives and memory. There are several types of disk drives: hard, floppy, magneto-optical, and compact. Hard disk drives store information in magnetic particles embedded in a disk. Usually a permanent part of the computer, hard disk drives can store large amounts of information and retrieve that information very quickly. Floppy disk drives also store information in magnetic particles embedded in removable disks that may be floppy or rigid. Floppy disks store less information than a hard disk drive and retrieve the information at a much slower rate. Magneto-optical disc drives store information on removable discs that are sensitive to both laser light and magnetic fields. They can typically store as much information as hard disks, but they have slightly slower retrieval speeds. Compact disc drives store information on pits burned into the surface of a disc of reflective material. CD-ROMs can store about as much information as a hard drive but have a slower rate of information retrieval. A digital video disc (DVD) looks and works like a CD-ROM but can store more than 15 times as much information.

Memory refers to the computer chips that store information for quick retrieval by the CPU. Random access memory (RAM) is used to store the information and instructions that operate the computer's programs. Typically, programs are transferred from storage on a disk drive to RAM. RAM is also known as volatile memory because the information within the computer chips is lost when power to the computer is turned off. Read-only memory (ROM) contains critical information and software that must be permanently available for computer operation, such as the operating system that directs the computer's actions from start up to shut down. ROM is called non-volatile memory because the memory chips do not lose their information when power to the computer is turned off.

Some devices serve more than one purpose. For example, floppy disks may also be used as input devices if they contain information to be used and processed by the computer user. In addition, they can be used as output devices if the user wants to store the results of computations on them.

**18.5. Hardware Connections**

To function, hardware requires physical connections that allow components to communicate and interact. A bus provides a common interconnected system composed of a group of wires or circuitry that coordinates and moves information between the internal parts of a computer. A computer bus consists of two channels, one that the CPU uses to locate data, called the address bus, and another to send the data to that address, called the data bus. A bus is characterized by two features: how much information it can manipulate at one time, called the bus width, and how quickly it can transfer these data.

A serial connection is a wire or set of wires used to transfer information from the CPU to an external device such as a mouse, keyboard, modem, scanner, and some types of printers. This type of connection transfers only one piece of data at a time, and is therefore slow. The advantage to using a serial connection is that it provides effective connections over long distances.

A parallel connection uses multiple sets of wires to transfer blocks of information simultaneously. Most scanners and printers use this type of connection. A parallel connection is much faster than a serial connection, but it is limited to distances of less than 3 m (10 ft) between the CPU and the external device.

BD18217_ **You may want to go back to the key words listed at the beginning of the unit and check that you are familiar with each one. Give their Romanian equivalents (if necessary, you can use the glossary provided at the end of the textbook).**

**EXERCISES**

**A. READING**

**The purpose of the following exercises is to develop reading strategies and reinforce topic related vocabulary, not to check background knowledge.**

**A.1. Having read the text, decide whether the information given in the statements below is true (T) or false (F). Correct the false statements (the specifications in brackets refer o the section in the text where the answer can be found):**

1. A parallel connection uses multiple sets of wires to transfer blocks of information simultaneously. (18.5.)

2. A serial connection is a wire or set of wires used to transfer information from the CPU to another internal device such as a mouse, keyboard, modem, scanner, and some types of printers. (18.5.)

3. A CRT -based screen displays visual information on a flatter and smaller screen than a LCD -based video monitor. (18.3.)

4. A video display, or screen, converts information generated by the computer into visual information. (18.3.)

5. The analogue signal sent from one computer is converted by the modem into a digital signal, which is then transmitted by telephone lines or television cables to the receiving modem, which converts the signal back into a digital signal that the receiving computer can understand. (18.2.)

**A.2. Fill in the following table with information about different hardware components given in the text. Some of the spaces may remain blank, as the information is not given.**

**List 18.1.**

floppy disk drive, modem , video display , printer, bus, hard disk drive, keyboard , light pen, magneto-optical disc drive, mouse, optical scanner, compact disc drive, joystick;

**Table 18.1.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Type of hardware** | **Component** | **Function** | **Existing types of** | **Abbreviation** | **Features&Functional parameters** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**B. VOCABULARY WORK**

**The purpose of the following exercises is to promote the acquisition of new lexical items by providing collocations, terms followed by prepositions lexical sets and translations of the terms considered relevant to the topic.**

**B.1. Fill in the following grids with the missing terms:**

**Grid 1. (see 18.2.)**

**Grid 2. (see 18.3.)**

**Grid 3. (see 18.4.)**

**B.2. Fill in the gaps in the following text with the terms randomly listed below:**

**List 18.1.**

cathode ray tube, detection device, modem, liquid crystal display, on-screen pointer, video screen, firmware, mouse, light sensitive, optical scanner, transmitted to or received from;

**Text 18.**

Since microprocessors have both hardware and software aspects they are therefore often referred to as\_\_\_\_\_\_\_\_\_\_\_\_\_\_. A light pen is a stylus with a \_\_\_\_\_\_\_\_\_\_tip that is used to draw directly on a computer's \_\_\_\_\_\_\_\_\_\_\_\_or to select information on the screen by pressing a clip in the light pen or by pressing the light pen against the surface of the screen. A \_\_\_\_\_\_\_\_ is a pointing device designed to be gripped by one hand. It has a \_\_\_\_\_\_\_\_\_\_\_(usually a ball) on the bottom that enables the user to control the motion of an\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or cursor, by moving the mouse on a flat surface. An \_\_\_\_\_\_\_\_\_\_\_\_\_ uses light-sensing equipment to convert images such as a picture or text into electronic signals that can be manipulated by a computer. A \_\_\_\_\_\_\_\_\_\_, which stands for *mod*ulator*-dem*odulator, is a device that connects a computer to a telephone line or cable television network and allows information to be \_\_\_\_\_\_\_\_\_\_\_\_\_another computer. Displays commonly take one of two forms: a video screen with a \_\_\_\_\_\_\_\_\_(CRT) or a video screen with a \_\_\_\_\_\_\_\_\_ (LCD).

**C. LANGUAGE FOCUS**

**The purpose of the following exercises is to develop language awareness in terms of conveying generic meaning using the DEFINITE ARTICLE, the INDEFINITE ARTICLE and the ZERO ARTICLE.**

**C.1. Re-read section 18.2. identify the articles before nouns and decide on the uses of these types of articles ( generic meaning, definite, indefinite) grouping them into the following categories according to the pattern:**

**1. [ the + noun ]**

**2. [a/an + noun]**

**3. [ 0 art.+ noun ]**

**C.2. Analyse the list in C.1. and find out what form of the noun (singular or plural) is used in each case and try to identify the three possibilities of conveying generic meaning by special use of articles.**

**D. TRANSLATION**

**The purpose of this exercise is to develop translating skills.**

**D.1. Translate the following text into Romanian:**

Computer hardware consists of the components that can be physically handled. A light pen is a stylus with a light sensitive tip that is used to draw directly on a computer's video screen or to select information on the screen by pressing a clip in the light pen or by pressing the light pen against the surface of the screen. An optical scanner uses light-sensing equipment to convert images such as a picture or text into electronic signals that can be manipulated by a computer. For example, a photograph can be scanned into a computer and then included in a text document created on that computer. Output hardware consists of external devices that transfer information from the computer's CPU to the computer user. Displays commonly take one of two forms: a video screen with a cathode ray tube (CRT) or a video screen with a liquid crystal display (LCD). LCDs are frequently used in laptop computers.

**D.2. Comment on the difference between source-language text and target-language text, in point of conveying generic meaning when translating nouns with articles:**

**E. SPEAKING**

**The purpose of these exercises is to develop speaking skills with a focus on**

**E.1. Present to your colleagues the information about input hardware (Group 1), output hardware (Group 2) and storage hardware (Group 3) and ask them to provide examples for the described devices.**

**E.2. Ask the other group for a general description of different types of hardware. Use three different ways of asking, according to the patterns provided in C.2. Take turns in asking and answering your colleagues’ questions.**

**Role play**

**Group A: What is a keyboard?/What are keyboards?/What is the keyboard?**

**Group B: A keyboard is…/ Keyboards are…/ The keyboard is….**

**Unit 19**

**MICROPROCESSOR**

**AIM:**

To recognize the English technical terms related to microprocessor technology;

**OBJECTIVES:**

On successfully completing this unit the student should be able to:

* identify correctly the terms defining types of computer memory;
* recognise the specific terms related to microcontrollers;
* characterise the construction of microprocessors;
* identify the types of equipment used for executing a large number of instructions simultaneously;
* describe semiconductor technology;
* assimilate at least 30 terms specific of microprocessors;

**KEY TERMS:**

*CPU , computational control, advanced electronic systems, ultra-large-scale integrated circuit, amplifiers, oscillators, switches, resistors, diodes, capacitors, wires, arithmetic/logic unit (ALU), logical decisions, decipher, on-chip computation, specialized memory, cache memory, bus widths of 64 bits, crystal oscillator, clock signal, static RAM (SRAM), dynamic RAM (DRAM), microcontroller, nanoseconds, biasing of p- and n-type regions, metal-oxide semiconductor field-effect transistor (MOSFET), two n-type regions, source, the drain, p-type region, channel, layer of nonconductive silicon dioxide, gate, forward bias, dies, circuit patterns, silicon wafer, deposition, removal, conducting materials, insulating materials, semi conducting materials, micron, substrate creation, oxidation, lithography, etching, ion implantation, film deposition, ultra pure silicon substrate, smoothness, diameter, non-conducting layer, dielectric, oxygen, angstroms, photolithography, photo resist, resist, wavelength, to etch, wet etching, exposure to a corrosive gas, plasma, vacuum chamber, boron, ionizing, propelling, ion implanter, film, sputterers, evaporation, chemical-vapour deposition, fraction of a micron, speck of dust, class 1, cubic foot of air, Intel 4004, general-purpose microprocessor, Intel Pentium Pro, Digital Equipment Corporation's Alpha 21164A,*

**MICROPROCESSOR**

**19.1. Introduction**

Microprocessor, electronic circuit that functions as the central processing unit (CPU) of a computer, providing computational control. Microprocessors are also used in other advanced electronic systems, such as computer printers, automobiles, and jet airliners.

The microprocessor is one type of ultra-large-scale integrated circuit. Integrated circuits, also known as microchips or chips, are complex electronic circuits consisting of extremely tiny components formed on a single, thin, flat piece of material known as a semiconductor. Modern microprocessors incorporate transistors (which act as electronic amplifiers, oscillators, or, most commonly, switches), in addition to other components such as resistors, diodes, capacitors, and wires, all packed into an area about the size of a postage stamp.

A microprocessor consists of several different sections: The arithmetic/logic unit (ALU) performs calculations on numbers and makes logical decisions; the registers are special memory locations for storing temporary information much as a scratch pad does; the control unit deciphers programs; buses carry digital information throughout the chip and computer; and local memory supports on-chip computation. More complex microprocessors often contain other sections—such as sections of specialized memory, called cache memory, to speed up access to external data-storage devices. Modern microprocessors operate with *bus* *widths* of 64 *bits* (binary digits, or units of information represented as 1s and 0s), meaning that 64 bits of data can be transferred at the same time.

A crystal oscillator in the computer provides a clock signal to coordinate all activities of the microprocessor. The clock speed of the most advanced microprocessors allows billions of computer instructions to be executed every second.

**19.2. Computer Memory**

Because the microprocessor alone cannot accommodate the large amount of memory required to store program instructions and data, such as the text in a word-processing program, transistors can be used as memory elements in combination with the microprocessor. Separate integrated circuits, called random-access memory (RAM) chips, which contain large numbers of transistors, are used in conjunction with the microprocessor to provide the needed memory. There are different kinds of random-access memory. Static RAM (SRAM) holds information as long as power is turned on and is usually used as cache memory because it operates very quickly. Another type of memory, dynamic RAM (DRAM), is slower than SRAM and must be periodically refreshed with electricity or the information it holds is lost. DRAM is more economical than SRAM and serves as the main memory element in most computers.

**19.3. Microcontroller**

A microprocessor is not a complete computer. It does not contain large amounts of memory or have the ability to communicate with input devices—such as keyboards, joysticks, and mice—or with output devices, such as monitors and printers. A different kind of integrated circuit, a microcontroller, is a complete computer on a chip, containing all of the elements of the basic microprocessor along with other specialized functions. Microcontrollers are used in video games, videocassette recorders (VCRs), automobiles, and other machines.

**19.4. Semiconductors**

All integrated circuits are fabricated from semiconductors*,* substances whose ability to conduct electricity ranks between that of a conductor and that of a non-conductor, or insulator. Silicon is the most common semiconductor material. Because the electrical conductivity of a semiconductor can change according to the voltage applied to it, transistors made from semiconductors act like tiny switches that turn electrical current on and off in just a few *nanoseconds* (billionths of a second). This capability enables a computer to perform many billions of simple instructions each second and to complete complex tasks quickly.

The basic building block of most semiconductor devices is the *diode,* a junction, or union, of negative-type (n-type) and positive-type (p-type) materials. The terms *n-type* and *p-type* refer to semi conducting materials that have been *doped*—that is, have had their electrical properties altered by the controlled addition of very small quantities of impurities such as boron or phosphorus. In a diode, current flows in only one direction: across the junction from the p- to n-type material, and then only when the p-type material is at a higher voltage than the n-type. The voltage applied to the diode to create this condition is called the forward bias. The opposite voltage, for which current will not flow, is called the reverse bias. An integrated circuit contains millions of p-n junctions, each serving a specific purpose within the millions of electronic circuit elements. Proper placement and biasing of p- and n-type regions restrict the electrical current to the correct paths and ensure the proper operation of the entire chip.

**19.5. Transistors**

The transistor used most commonly in the microelectronics industry is called a metal-oxide semiconductor field-effect transistor (MOSFET). It contains two n-type regions, called the source and the drain, with a p-type region in between them, called the channel. Over the channel is a thin layer of nonconductive silicon dioxide topped by another layer, called the gate. For electrons to flow from the source to the drain, a voltage (forward bias) must be applied to the gate. This causes the gate to act like a control switch, turning the MOSFET on and off and creating a logic gate that transmits digital 1s and 0s throughout the microprocessor.

**19.6. Construction of Microprocessors**

Microprocessors are fabricated using techniques similar to those used for other integrated circuits, such as memory chips. Microprocessors generally have a more complex structure than do other chips, and their manufacture requires extremely precise techniques.

Economical manufacturing of microprocessors requires mass production. Several hundred *dies,* or circuit patterns, are created on the surface of a silicon wafer simultaneously. Microprocessors are constructed by a process of deposition and removal of conducting, insulating, and semi conducting materials one thin layer at a time until, after hundreds of separate steps, a complex sandwich is constructed that contains all the interconnected circuitry of the microprocessor. Only the outer surface of the silicon wafer—a layer about 10 microns (about 0.01 mm/0.0004 in) thick, or about one-tenth the thickness of a human hair—is used for the electronic circuit. The processing steps include substrate creation, oxidation, lithography, etching, ion implantation, and film deposition.

The first step in producing a microprocessor is the creation of an ultra pure silicon substrate, a silicon slice in the shape of a round wafer that is polished to a mirror-like smoothness. At present, the largest wafers used in industry are 300 mm (12 in) in diameter.

In the oxidation step, an electrically nonconducting layer, called a dielectric, is placed between each conductive layer on the wafer. The most important type of dielectric is silicon dioxide, which is “grown” by exposing the silicon wafer to oxygen in a furnace at about 1000°C (about 1800°F). The oxygen combines with the silicon to form a thin layer of oxide about 75 angstroms deep (an angstrom is one ten-billionth of a meter).

Nearly every layer that is deposited on the wafer must be patterned accurately into the shape of the transistors and other electronic elements. Usually this is done in a process known as photolithography, which is analogous to transforming the wafer into a piece of photographic film and projecting a picture of the circuit on it. A coating on the surface of the wafer, called the photo resist or resist, changes when exposed to light, making it easy to dissolve in a developing solution. These patterns are as small as 0.13 microns in size. Because the shortest wavelength of visible light is about 0.5 microns, short-wavelength ultraviolet light must be used to resolve the tiny details of the patterns. After photolithography, the wafer is etched—that is, the resist is removed from the wafer either by chemicals, in a process known as wet etching, or by exposure to a corrosive gas, called a plasma, in a special vacuum chamber.

In the next step of the process, ion implantation, also called doping, impurities such as boron and phosphorus are introduced into the silicon to alter its conductivity. This is accomplished by ionizing the boron or phosphorus atoms (stripping off one or two electrons) and propelling them at the wafer with an ion implanter at very high energies. The ions become embedded in the surface of the wafer.

The thin layers used to build up a microprocessor are referred to as films. In the final step of the process, the films are deposited using sputterers in which thin films are grown in plasma; by means of evaporation, whereby the material is melted and then evaporated coating the wafer; or by means of chemical-vapour deposition, whereby the material condenses from a gas at low or atmospheric pressure. In each case, the film must be of high purity and its thickness must be controlled within a small fraction of a micron.

Microprocessor features are so small and precise that a single speck of dust can destroy an entire die. The rooms used for microprocessor creation are called clean rooms because the air in them is extremely well filtered and virtually free of dust. The purest of today's clean rooms are referred to as class 1, indicating that there is no more than one speck of dust per cubic foot of air. (For comparison, a typical home is class one million or so.)

**19.7. History of the Microprocessor**

The first microprocessor was the Intel 4004, produced in 1971. Originally developed for a calculator, and revolutionary for its time, it contained 2,300 transistors on a 4-bit microprocessor that could perform only 60,000 operations per second. The first 8-bit microprocessor was the Intel 8008, developed in 1972 to run computer terminals. The Intel 8008 contained 3,300 transistors. The first truly general-purpose microprocessor, developed in 1974, was the 8-bit Intel 8080, which contained 4,500 transistors and could execute 200,000 instructions per second. By 1989, 32-bit microprocessors containing 1.2 million transistors and capable of executing 20 million instructions per second had been introduced.

In the 1990s the number of transistors on microprocessors continued to double nearly every 18 months. The rate of change followed an early prediction made by American semiconductor pioneer Gordon Moore. In 1965 Moore predicted that the number of transistors on a computer chip would double every year, a prediction that has come to be known as Moore’s Law. In the mid-1990s chips included the Intel Pentium Pro, containing 5.5 million transistors; the UltraSparc-II, by Sun Microsystems, containing 5.4 million transistors; the PowerPC620, developed jointly by Apple, IBM, and Motorola, containing 7 million transistors; and the Digital Equipment Corporation's Alpha 21164A, containing 9.3 million transistors. By the end of the decade microprocessors contained many millions of transistors, transferred 64 bits of data at once, and performed billions of instructions per second.

BD18217_ **You may want to go back to the key words listed at the beginning of the unit and check that you are familiar with each one. Give their Romanian equivalents (if necessary, you can use the glossary provided at the end of the textbook).**

**EXERCISES**

**A. READING**

**The purpose of the following exercises is to develop reading strategies and reinforce topic related vocabulary, not to check background knowledge.**

**A.1. Having read the text, decide whether the information given in the statements below is true (T) or false (F). Correct the false statements (the specifications in brackets refer o the section in the text where the answer can be found):**

1. Microprocessor, electronic circuit that functions as the central processing unit (CPU) of a computer, providing computational control. (19.1.)

2. The arithmetic/logic unit (ALU) performs calculations on numbers and makes logical decisions; the registers are special memory locations for carrying temporary information much as a scratch pad does; the control unit deciphers programs; buses store digital information throughout the chip and computer; and local memory supports on-chip computation. (19.1.)

3. Another type of memory, dynamic RAM (DRAM), is faster than SRAM and must be periodically refreshed with electricity or the information it holds is lost. (19.2.)

4. A different kind of integrated circuit, a microcontroller, is a complete computer on a chip, containing all of the elements of the basic microprocessor along with other specialized functions. (19.3.)

5. Because the electrical conductivity of a semiconductor can change according to the voltage applied to it, transistors made from semiconductors act like tiny switches that turn electrical current on and off in just a few *nanoseconds* (millionths of a second). (19.4.)

6. The terms *n-type* and *p-type* refer to semi conducting materials that have been *doped*—that is, have had their electrical properties altered by the controlled addition of very small quantities of impurities such as boron or phosphorus. (19.4.)

7. The transistor used most rarely in the microelectronics industry is called a metal-oxide semiconductor field-effect transistor (MOSFET). (19.5.)

8. Several hundred *diodes,* or circuit patterns, are created on the surface of a silicon wafer simultaneously. (19.6.)

9. The most important type of dielectric is silicon dioxide, which is “grown” by exposing the silicon wafer to oxygen in a furnace at about 1000°C (about 1800°F). (19.6.)

10. Microprocessor features are so small and precise that a single speck of dust can destroy an entire die. The rooms used for microprocessor creation are called clean rooms because the air in them is extremely well filtered and virtually free of dust. The purest of today's clean rooms are referred to as class A, indicating that there is no more than one speck of dust per cubic foot of air. (19.6.)

**A.2. Read section 19.6. to identify the stages in the construction process of microprocessors presented . Give a title and label each stage.**

**B. VOCABULARY WORK**

**The purpose of the following exercises is to promote the acquisition of new lexical items by providing collocations, terms followed by prepositions lexical sets and translations of the terms considered relevant to the topic.**

**B.1. Enter in the following table information related to the development of microprocessors along history (see section 19.10):**

**Table 19.1.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Name of the microprocessor** | **Year it was developed** | **Number of transistors it contained** | **Microprocessor capacity** | **Number of operations per second** | **Developed by** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**B.2. Fill in the gaps in the following text with the terms randomly listed below:**

**List 19.1.:**

Oxygen, applied , higher , photo resist or resist , conduct electricity , ultra pure silicon substrate, junction , dies , dielectric, semiconductor, outer, logical, conductor , microchips or chips, arithmetic/logic unit, insulator, conductivity, forward bias, silicon wafer, microns, ion implantation,

1. Integrated circuits, also known as\_\_\_\_\_\_\_\_\_\_\_\_\_, are complex electronic circuits consisting of extremely tiny components formed on a single, thin, flat piece of material known as a\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

2. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_(ALU) performs calculations on numbers and makes \_\_\_\_\_\_\_\_\_\_decisions.

3. All integrated circuits are fabricated from semiconductors*,* substances whose ability to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ranks between that of a \_\_\_\_\_\_\_\_\_and that of a non-conductor, or\_\_\_\_\_\_\_\_\_.

4. In a diode, current flows in only one direction: across the \_\_\_\_\_\_\_\_\_from the p- to n-type material, and then only when the p-type material is at a \_\_\_\_\_\_\_\_\_voltage than the n-type. The voltage\_\_\_\_\_\_\_\_ to the diode to create this condition is called the\_\_\_\_\_\_\_\_\_\_.

5. Several hundred\_\_\_\_\_\_\_\_\_\_*,* or circuit patterns, are created on the surface of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_simultaneously.

6. Only the \_\_\_\_\_\_surface of the silicon wafer—a layer about 10 \_\_\_\_\_\_(about 0.01 mm/0.0004 in) thick, or about one-tenth the thickness of a human hair—is used for the electronic circuit.

7. The first step in producing a microprocessor is the creation of an\_\_\_\_\_\_\_\_\_\_\_\_\_, a silicon slice in the shape of a round wafer that is polished to a mirror-like smoothness.

8. The most important type of \_\_\_\_\_\_is silicon dioxide, which is “grown” by exposing the silicon wafer to \_\_\_\_\_\_\_in a furnace at about 1000°C (about 1800°F).

9. A coating on the surface of the wafer, called the\_\_\_\_\_\_\_\_\_\_\_\_, changes when exposed to light, making it easy to dissolve in a developing solution.

10. In the next step of the process, \_\_\_\_\_\_\_\_\_\_\_\_\_, also called doping, impurities such as boron and phosphorus are introduced into the silicon to alter its\_\_\_\_\_\_\_\_.

**C. LANGUAGE FOCUS: USE OF NUMERALS**

**The purpose of the following exercises is to develop language awareness in terms writing and pronouncing numbers.**

**C.1. Enter the following terms containing numerals under the appropriate heading in the table below:**

**List 19.2.**

|  |  |
| --- | --- |
| 64 bits  645 times  1s and 0s  billions of computer instructions  billionths of a second  billions of simple instructions  one direction  millions of p-n junctions  millions of electronic circuit elements  two n-type regions  several hundred dies   * 1. mm/0.0004 in   one-tenth the thickness of a human hair  the first step  300 mm (12 in)  1000°C (about 1800°F)  75 angstroms  one ten-billionth of a meter  0.13 microns in size  0.5 microns  one or two electrons   * 1. million transistors   UltraSparc-II  PowerPC620 | as class 1  one speck of dust per cubic foot of air  The first microprocessor  Intel 4004  Triple  1971  2,300 transistors  ten times  4-bit microprocessor  60,000 operations per second  once  8-bit microprocessor  Intel 8008  double  1972  3,300 transistors  tenfold  1974  4,500 transistors  1.2 million transistors  20 million instructions per second  in the 1990s  18 months  in the mid-1990s |

**TABLE 19.2.**

|  |  |  |  |
| --- | --- | --- | --- |
| **ORDINAL NUMERAL** | **CARDINAL NUMERAL** | **MULTIPLICATIVE NUMERAL** | **FRACTIONAL/DECIMAL NUMERAL** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**C. 2. Form all types of numerals for the following and write them in terms under the appropriate heading in C.1.:**

0; 1; 5; 11; 12; 13; 14; 19; 20; 21; 30; 32; 99; 100; 101; 11; 117; 128; 648; 1000; 1001; 1010; 1011; 1112; 4678; 40,000; 67,431; 674,674; 1,000,000; 1,000,001; 3,345,345; 345,345,345; 1,000,000,000;

**C.3. Identify the corresponding numeral-formation pattern, choosing from the following. Pay attention to the spelling and pronunciation.**

**A. [CARDINAL NUMERAL: HUNDREDS + *and +* TENTHS *+ - +* UNITS]**

**B. [ORDINAL NUMERAL: *the* + cardinal numeral + *th(st,rd,nd)*]**

**C. [MULTIPLICATIVE NUMRERAL: cardinal numeral + *TIMES/FOLD*]**

**D. [FRACTIONAL NUMERAL: cardinal numeral/ ordinal numeral + (s)]**

**E. [DECIMAL NUMERAL: cardinal numeral + *point* + digits]**

**D. TRANSLATION**

**The purpose of this exercise is to develop translating skills.**

**D.1. Translate the following numerals from and into English. Focus on the word formation/writing differences between Romanian and English forms.**

**Table 19.3.**

|  |  |
| --- | --- |
| **ROMANIAN** | **ENGLISH** |
| 0,005 |  |
|  | 3,046 |
| 6.764 |  |
|  | 6.764 |
| 10.000.000 |  |

**E. SPEAKING**

**The purpose of these exercises is to develop speaking skills with a focus on describing microprocessor parameters using numerals.**

**E.1. Talk with one of your colleagues and name one type of microprocessor (see section 19.7.).Take turns to ask for and provide information relating to that particular type of microprocessor.**

**Unit 20**

**CENTRAL PROCESSING UNIT**

**AIM:**

To recognize the English technical terms related to the central processing unit;

**OBJECTIVES:**

On successfully completing this unit the student should be able to:

* identify correctly the terms defining the main information processor of a computer;
* recognise the specific terms related to the CPU operation principles;
* characterise the general CPU function;
* identify the types of instructions;
* describe fixed-point and floating point numbers’
* assimilate at least 30 terms specific of CPU parameters;

**KEY TERMS:**

*CPU, microscopic circuitry, main information processor, interconnected processing units, standard CPU, to interpret software instructions, to implement software instructions, to perform calculations, to perform comparisons, to make logical decisions, to temporarily store information, is to perform arithmetic / logical operations, software instructions, data flow, interface unit, decode, instruction decoder, arithmetic/logic unit (ALU), registers, program counter, special instructions, branch / jump instructions, unconditional branch, conditional branch, flags, repetitive clock circuits, constant stream of pulses, clock pulses, to synchronize, increment, sequential clock pulses, clock period, Hertz, megahertz, fixed-point, floating-point numbers, decimal point, scientific notation, special floating-point processor, coprocessor.*

**CENTRAL PROCESSING UNIT**

**20.1. Introduction**

Central Processing Unit (CPU), in computer science, microscopic circuitry that serves as the main information processor in a computer. A CPU is generally a single microprocessor made from a wafer of semi conducting material, usually silicon, with millions of electrical components on its surface. On a higher level, the CPU is actually a number of interconnected processing units that are each responsible for one aspect of the CPU’s function. Standard CPUs contain processing units that interpret and implement software instructions, perform calculations and comparisons, make logical decisions (determining if a statement is true or false based on the rules of Boolean algebra), temporarily store information for use by another of the CPU’s processing units, keep track of the current step in the execution of the program, and allow the CPU to communicate with the rest of the computer.

**20.2. How a CPU Works**

**20.2.1. CPU Function**

A CPU is similar to a calculator, only much more powerful. The main function of the CPU is to perform arithmetic and logical operations on data taken from memory or on information entered through some device, such as a keyboard, scanner, or joystick. The CPU is controlled by a list of software instructions, called a computer program. Software instructions entering the CPU originate in some form of memory storage device such as a hard disk, floppy disk, CD-ROM, or magnetic tape. These instructions then pass into the computer’s main random access memory (RAM), where each instruction is given a unique address, or memory location. The CPU can access specific pieces of data in RAM by specifying the address of the data that it wants.

As a program is executed, data flow from RAM through an interface unit of wires called the bus, which connects the CPU to RAM. The data are then decoded by a processing unit called the instruction decoder that interprets and implements software instructions. From the instruction decoder the data pass to the arithmetic/logic unit (ALU), which performs calculations and comparisons. Data may be stored by the ALU in temporary memory locations called registers where it may be retrieved quickly. The ALU performs specific operations such as addition, multiplication, and conditional tests on the data in its registers, sending the resulting data back to RAM or storing it in another register for further use. During this process, a unit called the program counter keeps track of each successive instruction to make sure that the program instructions are followed by the CPU in the correct order.

**20.2.2. Branching Instructions**

The program counter in the CPU usually advances sequentially through the instructions. However, special instructions called branch or jump instructions allow the CPU to abruptly shift to an instruction location out of sequence. These branches are either unconditional or conditional. An unconditional branch always jumps to a new, out of order instruction stream. A conditional branch tests the result of a previous operation to see if the branch should be taken. For example, a branch might be taken only if the result of a previous subtraction produced a negative result. Data that are tested for conditional branching are stored in special locations in the CPU called flags.

**20.2.3. Clock Pulses**

The CPU is driven by one or more repetitive clock circuits that send a constant stream of pulses throughout the CPU’s circuitry. The CPU uses these clock pulses to synchronize its operations. The smallest increments of CPU work are completed between sequential clock pulses. More complex tasks take several clock periods to complete. Clock pulses are measured in Hertz, or number of pulses per second. For instance, a 100-megahertz (100-MHz) processor has 100 million clock pulses passing through it per second. Clock pulses are a measure of the speed of a processor.

**20.2.4. Fixed-Point and Floating-Point Numbers**

Most CPUs handle two different kinds of numbers: fixed-point and floating-point numbers. Fixed-point numbers have a specific number of digits on either side of the decimal point. This restriction limits the range of values that are possible for these numbers, but it also allows for the fastest arithmetic. Floating-point numbers are numbers that are expressed in scientific notation, in which a number is represented as a decimal number multiplied by a power of ten. Scientific notation is a compact way of expressing very large or very small numbers and allows a wide range of digits before and after the decimal point. This is important for representing graphics and for scientific work, but floating-point arithmetic is more complex and can take longer to complete. Performing an operation on a floating-point number may require many CPU clock periods. A CPU’s floating-point computation rate is therefore less than its clock rate. Some computers use a special floating-point processor, called a coprocessor that works in parallel to the CPU to speed up calculations using floating-point numbers. This coprocessor has become standard on many personal computer CPUs, such as Intel’s Pentium chip.

BD18217_ **You may want to go back to the key words listed at the beginning of the unit and check that you are familiar with each one. Give their Romanian equivalents (if necessary, you can use the glossary provided at the end of the textbook).**

**EXERCISES**

**A. READING**

**The purpose of the following exercises is to develop reading strategies and reinforce topic related vocabulary, not to check background knowledge.**

**A.1. Having read the text, answer the following questions (the specifications in brackets refer to the section in the text where the answer can be found):**

1. What is the CPU? (20.1.)

2. What does it consist of? (20.1.)

3. What are its functions? (20.2.1.)

4. What are branching instructions? (20.2.2)

5. Which are the two main types of jump instructions? (20.2.2)

6. What does each do? (20.2.2.)

7. What are clock pulses? (20.2.3.)

8. What does the CPU use clock pulses for? (20.2.3.)

9. What is the difference between fixed-point numbers and floating-point numbers and which are their implications? (20.2.4.)

10. What is the CPU’s floating-point computation rate as compared to its clock rate? (20.2.4)

**A.2. Re-read section 20.2.1.and also using your background knowledge, order the CPU’s operation stages correctly by entering them into the table below.**

**List 20.1.**

|  |  |
| --- | --- |
| -computer’s main random access memory (RAM);  -CPU can access specific pieces of data in RAM;  -performing arithmetic and logical operations;  -from the instruction decoder the data pass to the arithmetic/logic unit (ALU), which performs calculations and comparisons;  -the ALU performs specific operations sending the resulting data back to RAM or storing it in another register for further use; | -is controlled by a list of software instructions;  -data are then decoded by a processing unit called the instruction decoder that interprets and implements software instructions  each instruction is given a unique address;  - a unit called the program counter keeps track of each successive instruction to make sure that the program instructions are followed by the CPU in the correct order  -Software instructions;  -data flows from RAM through an interface unit of wires called the bus, which connects the CPU to RAM; |

**Table 20.1.**

|  |  |
| --- | --- |
| 1  3  5  7  9 | 2  4  6  8  10 |

**B. VOCABULARY WORK**

**The purpose of the following exercises is to promote the acquisition of new lexical items by providing collocations, terms followed by prepositions lexical sets and translations of the terms considered relevant to the topic.**

**B.1. Match the terms in column A with the word in column B that completes the term (some terms in column B can be used more than once):**

**Table 20.2.**

**A B**

|  |  |
| --- | --- |
| interconnected processing  conditional  software  logical  interface  memory storage  data  arithmetic/logic  branch / jump  unconditional  clock  fixed-point  floating-point  decimal | circuits  flow  device  point  decisions  branch  numbers  instructions  units  unit  pulses |

**B.2. Fill in the gaps in the following text with the terms randomly listed below:**

**List 20.2.**

Implement, temporarily, units, calculations, true or false, standard, execution, Boolean,

1. \_\_\_\_\_\_\_\_\_\_\_\_CPUs contain processing units that interpret and \_\_\_\_\_\_\_\_software instructions, perform \_\_\_\_\_\_\_\_\_\_\_\_\_and comparisons, make \_\_\_\_\_\_\_\_\_\_decisions (determining if a statement is \_\_\_\_\_\_\_\_\_\_ based on the rules of \_\_\_\_\_\_\_\_algebra), \_\_\_\_\_\_\_\_ store information for use by another of the CPU’s processing\_\_\_\_\_\_\_, keep track of the current step in the \_\_\_\_\_\_\_\_\_of the program, and allow the CPU to communicate with the rest of the computer.

**C. LANGUAGE FOCUS: SEQUENCE MAKERS**

**The purpose of the following exercises is to develop language awareness in terms of connectives used for describing a process or procedure, when the sequence of operation is of high relevance.**

**C.1. Sequence, or order, is important in both describing a process and reporting a procedure. Re-read section 20.2.1. and underline all sequence makers you recognize.**

**C.2. Group then according to their meaning and complete the list with other terms of the same type that do not appear in the text.**

**Table 20.3.**

|  |  |  |
| --- | --- | --- |
| **SIMULTANEOUSLY** | **PRIORLY** | **SUBSEQUENTLY** |
|  |  |  |
|  |  |  |
|  |  |  |

**D. TRANSLATION**

**The purpose of this exercise is to develop translating skills.**

**D.1. Translate the following text into Romanian:**

Scientific notation is a compact way of expressing very large or very small numbers and allows a wide range of digits before and after the decimal point. This is important for representing graphics and for scientific work, but floating-point arithmetic is more complex and can take longer to complete. Performing an operation on a floating-point number may require many CPU clock periods. A CPU’s floating-point computation rate is therefore less than its clock rate. Some computers use a special floating-point processor, called a coprocessor that works in parallel to the CPU to speed up calculations using floating-point numbers. This coprocessor has become standard on many personal computer CPUs, such as Intel’s Pentium chip.

**E. SPEAKING**

**The purpose of these exercises is to develop speaking skills with a focus on expressing the sequence of different stages of a procedure or process.**

**E.1. Taking turns, describe the CPU’s operation stages presented in section 20.2.1. focusing on various ways to express sequence.**