Unit 6

PROCESSORS AND MEMORIES

1.1. Read and translate the following words and expressions.

A functional unit, a unique set of operations, the instruction set, a step-by-step operation, a regular heartbeat, the operation of the processor, an original instruction, the entire computer system, logical and computational capabilities, a current instruction, the size of pathways, the specific requirements, a specific integrated-circuit chip, controller functions, graphics processing.

1.2. Learn key words and word – combinations.

application-specific integrated circuit (ASIC) – спеціалізована інтегральна схема
arithmetic /logic unit (ALU) – арифметично-логічний пристрій
carry out the instruction – виконувати команду
central processing unit (CPU) – центральний процесор
clock (n) – годинник: тактовий генератор
computer speed – швидкодія комп'ютера
DSP (digital signal processor) – процесор цифрового опрацювання сигналів
execute (n) – виконувати
heartbeat (n) – тактовий імпульс
instruction set – набір команд
interrupt (n) – переривання
machine instruction – машинна команда
machine language – машинна мова
operand (n) – операнд
operation (n) – команда; операція
peripheral (n) – зовнішній пристрій

register (n) – регістр
resume (v) – продовжувати; відновлювати
retrieve (v) – знаходити, відновлювати
step-by-step – покроковий
storage location – комірка пам’яті
tape drive – накопичувач на магнітній стрічці
timer (n) – таймер; годинник
word size – довжина слова
workspace (n) – робоча ділянка

1.3. Read and translate the text.

What is a Processor?

A processor, also called a **central processing unit** or **CPU**, is a functional unit that interprets and carries out instructions. This is the central nervous system of the computer, and it is often contrasted to the devices that surround the processor and memory, such as keyboards, display screens, and disk and tape drives, which are known as **peripherals**. Every processor comes with a unique set of operations such as ADD, STORE, or LOAD that represent the processor’s instruction set. Computer designers are fond of calling their computers machines, so the instruction set is sometimes referred to as machine instructions and the binary language in which they are written is called machine language.

An instruction is made up of **operations** that specify the function to be performed and **operands** that represent the data to be manipulated. For example, if an instruction is to perform the operation of adding two numbers, it must know (1) what the two numbers are and (2) where the two numbers are. When the numbers are stored in the computer’s memory, they have an address to indicate where they are, so if an operand refers to data in the computer’s memory, it is called an address. The processor’s job is to retrieve instructions and data from memory and to perform each operation. Having done that, it signals memory to send it the next instruction.

This step-by-step operation is repeated over and over again at speeds measured in millionths of a second. A **timer** called a **clock** releases precisely timed electrical signals that provide a regular heartbeat for the processor’s work. Megahertz (MHz), which means million cycles per second, are used to measure the computer's speed. For example, in a 50-MHz processor, the computer's clock ticks 50 million times every second.

A processor is composed of two functional units – a **control unit** and an **arithmetic/logic unit** – as well as a set of special workspaces called **registers**.

The control unit is the functional unit that is responsible for supervising the operation of the processor. In some ways, it is analogous to an intelligent telephone switchboard because it makes the connections between various functional units of the computer system. It calls into operation each unit that is required by the program currently in operation. And like a switchboard with call waiting, the processor can be interrupted. An **interrupt** is a signal that tells the processor to put aside what it is doing and transfer control to another instruction. The processor resumes its original instruction when the interrupt is finished.

The control unit retrieves instructions from memory and determines their type or decodes them. It then breaks each instruction into a series of simple small steps or actions. By doing this, it controls the step-by-step operation of the entire computer system.

The arithmetic/logic unit (ALU) is the functional unit that provides the computer with logical and computational capabilities. Data are brought into the ALU by the control unit, and the ALU performs whatever arithmetic or logic operations are required to help carry out the instruction.

Arithmetic operations include adding, subtracting, multiplying, and dividing. Logic operations make a comparison and take action based on the results. For example, two numbers might be compared to determine whether they are equal. If they are equal, processing will continue; if they are not equal, processing will switch to another instruction.

A register is a **storage location** inside the processor. Registers in the control unit are used to keep track of the overall status of the program that is running. Control unit registers store information such as the current instruction, the location of the next instruction to be executed, and the operands of the instruction. In the ALU, registers store data items that are added, subtracted, multiplied, divided, and compared. Other registers store the results of arithmetic and logic operations.

An important factor that affects the speed and performance of a processor is the size and number of the registers. Technically, the term **word size** (also called **word length**) describes the size of an **operand register**, but it is also used more loosely to describe the size of the pathways to and from the processor. Currently, word sizes in computers range from 16 to 64 bits. If the operand registers of a processor are 32 bits wide, the processor is said to be a 32-bit processor.

Some processors are designed to add additional functions to the central processor. Math coprocessors relieve the central processor of the intensive numeric calculations required in scientific and technical applications. Digital signal processors (DSPs) assist the central processor in working with sound, speech, music, and image processing.

Other processors are designed to fill the specific requirements of an application. These processors are based on application-specific integrated circuits (ASIC). An early example of a product that uses an ASIC is the digital wrist-watch. The functions that a wristwatch performs are simple and easy to understand. Although a general-purpose processor could easily handle the functions of a watch, there is no need to do so, as it is much more economical to develop a specific integrated-circuit chip to do the job. A more recent example of ASIC combines all of the electronics of a personal computer (excluding microprocessor and memory) in a single chip. Today's specialized processor chips permit designers to build large amounts of computing power into all sorts of products, such as controller functions in appliances and automobiles, computer networking, speech recognition and syn-

the Control Unit	the ALU	registers	the CPU	a clock	MHz

1. ________ performs mathematical calculations and logical operations.
2. The high-speed units of memory used to store and control information are called ________ .
3. ________ examines the instructions in the user's program, interprets each instruction and the rest of the components to be activated to execute the functions specified.
4. ________ provides pulses at fixed intervals to measure and synchronize circuits and units.
5. The clock speed is measured in ________ and refers to the frequency at which pulses are emitted.
6. ________ controls the interpretation and execution of computer instructions. It functions by breaking down a complex task into a number of discrete, simple steps.

1.5. Put the verb into the correct form.

1. The speed of the microprocessor ________in MHz. (measure)
2. The CPU ________ into a single microprocessor chip. (build)
3. The first microcomputers, also known as PCs, ________ for single users only, and this clearly ________ them from minicomputers. (be, distinguish)
4. Today the division between "minis" and "micros" ________. (disappear)

1.6. Use the information in the text and match the terms in the box with the appropriate explanation or definition below.

the CPU	a clock	a register	peripherals	an interrupt	machine language

1. Physical units attached to the computer.
2. The "brain" of the computer.
3. A high-speed unit of memory used to store and control information.
4. The binary language in which the instructions are written.
5. A signal that causes a processor to suspend the current instruction and transfer control to another instruction.
6. A computer circuit that uses regular electrical pulses to trigger time and synchronize various events within a computer.

1.7. Answer the questions.

1. What is the nerve centre of the computer?
2. What functions does the CPU perform?
3. What devices are called peripherals?
4. What parts does the CPU consist of?
5. What is the Control Unit responsible for?
6. How important is an interrupt in the computer's operation?
7. What functional unit provides the computer with logical and computational capabilities?
8. What units of memory are responsible for storing and controlling information?
9. What does the abbreviation ASIC stand for?

2.1. Read and translate the following words and expressions.

A series of sells, a piece of information, storage capacity, electrical refreshing, memory cells, a two-dimensional array, a grid of rows and columns, a bus –

oriented computer, the size of available memory, a variable – length piece of memory, a fixed-length piece of memory, a memory management technique.

2.2. Learn key words and word – combinations.

access time – тривалість доступу
accessibility (n) – доступність
address bus – адресна шина
cache (n) – надоперативна пам’ять; кеш-пам’ять
cell (n) – комірка
control bus – контрольна шина
data bus – шина даних
DRAM (dynamic RAM) – динамічна оперативна пам’ять
memory hierarchy – ієрархія пам’яті
memory (n) – пам’ять
nonvolatile (adj) – енергонезалежний
paging – сторінкова організація
RAM disk – псевдодиск; віртуальний диск
RAM (random access memory) – оперативна пам’ять
ROM (read-only memory) – ПЗП; постійна пам’ять
routine (n) – операція
segmentation (n) – сегментація
storage capacity – місткість запам’ятовувального пристрою
swap (v) – перевантажувати
transfer (n) – передача (даних); пересилання; перехід
volatile (adj) – енергозалежний

2.3. Read and translate the text.

What is a Memory?

A processor cannot store all the information it needs while running a program, thus it depends on memory. **Memory** can be thought of as a series of cells, with each cell storing a piece of information. That piece of information is known as a **byte.** Memories are often rated in terms of their information storage capacity, which is usually measured in millions of bytes.

Memories are generally classified by the nature of the accessibility of the information and are divided into two major categories: random-access memory (RAM) and read-only memory (ROM).

Random-access memory (RAM) is a type of memory that can be read from or written to. Most RAM is actually **dynamic RAM** or **DRAM** (pronounced dee-ram). It is dynamic because it is constantly being refreshed with electrical pulses. Dynamic RAM loses its contents without constant electrical refreshing. There is a type of RAM, called **static RAM,** that needs very little power for refreshing, but it is not as widely used because it is more costly to produce. Because most RAM is dynamic, it is said to be volatile; that is, it loses its contents when the electric power is shut off.

Random access means that the cells of a RAM memory are organized so that the access time for any one cell is the same as that for any other cell. This is accomplished by arranging the memory cells in a two-dimensional array, in much the same way that a spreadsheet is arranged as a grid of rows and columns. Then a memory cell can be accessed by supplying an address that contains the row and column numbers of that cell.

Read-only memory (ROM) is a type of memory that can be read from but cannot be written to or altered. ROM is static or nonvolatile; that is, it retains its contents when the electric power is shut off. ROM can be used to store programs that perform specialized routines. For example, a portion of ROM might contain a program that performs division, so that when a program executes a DIVIDE instruction, it is actually executed using instructions in the ROM memory.

A **bus** is a circuit that provides a path for transferring information between two or more devices. In a bus-oriented computer, the processor, memory, and the input and output devices are connected by a set of three buses. When instructions and data share the same memory, they travel to and from the processor and memory over a common **data bus.** A second bus, called an **address bus,** carries the memory addresses in which specific data needed for instructions can be found. A third bus, called a **control bus,** is used to signal the various parts to transfer information and to signal the processor when the transfer is completed.

Memory management. In addition to physically larger and faster memories, several techniques permit memory to be used more advantageously. One such technique is **virtual memory,** which creates the illusion of a computer with more memory than it actually has by moving some data to disk. When a program needs to be larger than the size of available memory, the program is divided into a number of pieces. To run such a program, the first piece is brought into memory and executes until another piece of the program is needed. Then the second piece is brought in, and so on. The pieces into which a program is divided are called **segments** and **pages.** A segment is a variable-length piece of memory that a program allocates, whereas a page is a fixed-length piece of memory.

Segmentation is a memory management technique for allocating and addressing memory. Segments also provide structure (a program can consist of a collection of segments) and protection (other programs cannot access those segments). A segment is a convenient unit to swap into and out of memory, but because segments are of variable length, managing them in memory and on disk is complex and time-consuming. To overcome these problems, an additional technique called paging is used.

Paging is a memory management technique for mapping virtual addresses on disk to real addresses in memory. A program or segment that appears to be a single large piece of memory may actually be scattered throughout real memory in pages. The system handles segmentation and paging in such a way that the distinction between memory and the disk is invisible to the program.

Caching. A cache (pronounced cash) is a special memory subsystem in which frequently used instructions or data are stored for fast access by the processor. Processors, such as the i486, have a built-in cache. Rather than having a processor wait for information from RAM, the processor can read from and write to the cache. A cache is useful when processor speeds are high relative to memory access speeds.

Today, most computer systems use a **memory hierarchy**, that is, a series of levels of memory ranked one above the another on the basis of speed of access. Visualize a pyramid with a processor at the very top. At the next lower level of the hierarchy is the cache. At the next lower level is RAM memory, and beneath that is a RAM disk – a reserved section of relatively slow RAM that is used to store information normally located on an even slower disk. At the bottom of the pyramid is disk storage.

The memory hierarchy works as follows. A large program is divided into pages. The cache memory stores the most often used pages, the RAM memory and RAM disk will store the next most often used pages, and the least used pages are stored on disk. The combination of techniques can speed up processing because the number of times the program has to fetch instructions and data from RAM and disk memory is reduced.

2.4. Give synonyms of the following words.

Divide, major, need, alter, perform, instruction, connect, complete, permit, project, frequently, to fetch.

2.5. Complete the sentences using the words from the box. You can use some words more than once.

a cache memory	ROM	RAM	virtual memory

1. ___________ is a type of chip into which instructions are permanently embedded at the time of manufacture.
2. ___________ can be written to or read from and is often used for temporary storage of programs and data during processing.
3. ___________ is a special technique for expanding the capacity of main memory.
4. A very high-speed memory called ___________may have access times of less than 25 nanoseconds.
5. Information stored in ___________ is lost when the computer is turned off.

2.6. Give English equivalents of the following words and word – combinations.

Ряд комірок, керування пам'яттю, сторінкова організація, віртуальна пам'ять, двовимірний масив, завантажувати, енергонезалежний, розвантажувати, тривалість доступу, прямий/довільний доступ, спільна шина даних, енергозалежний, доступність інформації, виконувати спеціальні (стандартні) програми, створювати ілюзію, переміщати дані на диск.

2.7. In computer systems, memory can be thought of as a series of levels of memory ranked one above the other on the basis of speed. Draw a diagram representing these levels. The following types of memory must be included into the diagram: mass storage, processor, RAM memory, cache, RAM disk.

2.8. Answer the questions.

1. What is memory?
2. What are the main characteristics of ROM?
3. Why is RAM said to be volatile?

4. In what way are the cells of RAM organized?
5. What are the functions of data, address and control buses?
6. What do we call a memory which creates the illusion of a computer with more memory than it really has?
7. What are the techniques for memory management? What is the difference between them?
8. What type of memory holds the most –used data?
9. How does a memory hierarchy work?

3.1. Supplementary reading

Read and translate the texts. Make up a list of computer terms and learn them.

The Evolution of Computers

One trend that overshadows everything else is the miniaturization of electronic circuits. Computers have become smaller, faster, more reliable, and incredibly less expensive. This is largely due to the evolution of microelectronic technology, in which electronic logic is represented as microscopic circuits. Computer circuits have progressed from vacuum tubes to silicon chips that are smaller than a fingernail.

An important step in shrinking circuits involves integrating or combining several transistors and the circuits that connect them on one piece of semiconducting material. A **semiconductor** is a material whose electrical properties are less than a conductor, such as copper, and greater than an insulator, such as glass. Because of the small size and thinness of the semiconductor, it came to be known as a chip. The semiconductor material most commonly used is silicon. This accounts for the term **silicon chip** – a major solution to the problem of making computers faster, smaller, cheaper, and more reliable.

The only way to make a computer circuit significantly faster with electronic technology is to make it smaller. Although electricity theoretically travels at the speed of light (186,000 miles per second), resistance in wires and circuits can cut that speed well below the theoretical limit. For example, an electrical signal will travel about 10 inches in one billionth of a second. The distance the signals must travel can be significantly reduced by packing the circuits closer together, which speeds up the operation of the computer.

Very-large-scale integration (VLSI) packs 100,000 to 100 million components on each chip. Examples of VLSI include the 16-megabit RAM chip, the 1.2-million-transistor Motorola 68040 and i486 CISC microprocessors, and the 2.5-million-transistor i860 RISC processor. Integrated-circuit designers are routinely predicting that **ultralarge-scale integration (ULSI)** – chips with 100 million to 1 billion components – will be possible. When such a high level of integration occurs, it will be possible to put an entire computer system, including all processor and memory functions, on a single chip.

Computer builders first applied the concepts that we have discussed to the computers known as mainframes – large-scale computers used to process large volumes of data. The first mainframes were not the mass-produced computers that you know today. They were generally low-volume, handcrafted products, and as a result, they were large, complicated, and expensive to purchase and operate.

When the experts looked at the few large computers that were built in the early 1950s, they did not have the slightest notion that an industry was in the making. In 1948 IBM declined even to enter the computer industry. Why? Its marketing research department had predicted that there would never be enough demand to justify entering the commercial market. Legend has it that experts of the time predicted that from 12 to 50 of these modern electronic computers would satisfy all the computing needs of the entire commercial marketplace for years to come. However, by the mid-1960s, thousands of government, business, scientific, and educational institutions had computers. The applications for mainframe computers include the traditional data-processing applications for business, such as payroll, billing, accounting, and inventory control – jobs that typically require intensive input and output. In scientific applications, mainframes are used primarily for simulation and modelling – jobs that require fast, accurate, and extensive calculations.

One of the first important breakthroughs in efficiency occurred with the discovery of how to make computers perform computations and input/output operations at the same time. The von Neumann computer is designed with a single central processor through which all operations must be funnelled. All electronic computers are much faster than their slower input/output devices, which have to rely on the mechanical motion of a spinning disk or tape. Often, a processor has to wait while an input device, such as disk drive, reads data into memory. "Why not," reasoned the designers, "have the processor do something else while the data are being transferred to and from memory?" One way of doing this is to provide a separate processor called a **channel** to handle the flow of data into and out of memory. Then, the channel can transfer data in and out while the processor performs calculation-intensive operations. The channel can inform the processor when its input or output task is complete. In this way, the processor is able to execute instructions while input and output are occurring, which speeds up the overall operation of the computer.

Although channels are typically associated with mainframe computers, they can also be found in smaller computers in which a specialized channel processor implemented on a chip enables input/ output devices to move data in and out of memory without interrupting the central processor.

Another technique for increasing the overall efficiency of computer operations is **time-sharing** – the sharing of a single processor that switches back and forth among many separate programs in memory. An important application of time-sharing developed when owners of large computers wanted to share the processing power of their mainframes among many different users in different geographic locations. By connecting remote terminals to the time-shared mainframe, they allowed the central computer to service many users in a manner such that each person appeared to have complete use of the processor.

This was accomplished by a scheduling method known as **time-slicing, in** which many programs are each given a time slice during which a given program executes. During the heyday of timesharing, it was not uncommon to find companies with a single mainframe connected to hundreds of terminals in different geographic locations. However, because of the popularity of personal computers and networks of computers, time-sharing is on the decline.

When the integrated circuit was developed in the late 1960s, the designing and building of computers changed in two major ways: (1) integrated circuits allowed more transistors to be used to construct more complex circuits, and (2) they allowed processors to be mass produced. Mass production has the additional effect of rapidly decreasing the cost of building integrated circuits, so the two primary components – processors and memories – can be built much less expensively.

MINICOMPUTERS.

The combination of the declining cost of integrated circuits and the change in how processors and memories were designed and built launched a new breed of computers called minicomputers. Minicomputers (also called midrange computers) are physically smaller and cost far less than their mainframe forerunners, yet they are still powerful enough to do many of the jobs that only the big mainframes could do before. Because they are smaller and cheaper, several new ways of using computers have become possible that were not attractive before the minicomputer.

Distributed Computing. One of the major contributions of the minicomputer was the widespread adoption of distributed computing, in which a number of small computers can be distributed throughout an organization and take the place of one central computing facility. The lower cost of minicomputers made it possible to dedicate a computer to a single application. Departments of large organizations as well as small businesses began to purchase minicomputers to use as departmental processors. For example, the branch office of a large corporation that had previously been sharing time on a mainframe could now use a minicomputer to perform its record-keeping functions. The manufacturing department of a large organization could now use a minicomputer dedicated to running the factory. In the laboratory, scientists could use dedicated minicomputers to collect and analyze data gathered from experiments.

Multiuser Systems. Like mainframes, minicomputers were powerful enough to be used as time-sharing systems. For example, a medical clinic could use a minicomputer connected to several terminals to provide patient records to doctors, nurses, and administrative personnel. Similarly, a hotel could use a minicomputer system to connect terminals at the front desk, the manager's office, and the accounting department. Large office buildings could use minicomputers to control ventilation and heating systems scattered throughout their premises.

The term **workstation** refers to a high-end computer of the sort used in computer-aided design, engineering, and scientific research applications requiring considerable calculating and graphics capability. Inexpensive workstations are similar in size and performance to high-end personal computers. High-end workstations are not much larger but considerably more powerful and more expensive than personal computers. Although workstations can be used for a wide variety of tasks, one application called **scientific visualization** vividly demonstrates the power and capability of today's high-end workstations.

In scientific research, image-processing techniques called **scientific** visualization are used to interpret and visualize data captured by cameras and sensors. By turning these data into three-dimensional moving images, researchers are able to gain new insight into problems that are difficult or impossible to interpret with numbers or words.

Just as the minicomputer led to the widespread adoption of distributed computing, so the microprocessor has led to methods for taking advantage of many connected computers that run applications. One way to do this is through **client/server computing** – distributing the application into cooperating parts that are independent of one another. A **client** is an end user or computer program that requests resources across a network, a **server** is a computer running software that fulfils those requests across a network. The separation of functions means that each part can be developed or changed separately.

Microprocessors have also fueled the development of **fault-tolerant computers** – computers that use redundant components so that if one fails, a duplicate component can take over without interruption. Many of today's fault-tolerant computers are made by linking multiple microprocessors together.

Relying on a single computer or processor has its disadvantages. The term **crash** refers to a computer system that has become inoperable owing to an equipment malfunction or error in a program. The causes are varied. For example, (1) a logic circuit might fail or memory might fail, thus wiping out sections of a program or data, or (2) one altered instruction could cause the system to shut down suddenly or begin to process the wrong application or wrong information. In any time-sharing scheme, when the system crashes, all the users go down with it, and all must wait until the system is restored to resume work. A **fault** is similar to a crash and has become the standard term for the condition that causes a functional component to fail to operate in the required manner.

Hand-held or Palmtop Computers. One of the fastest growing areas is small hand-held portable computers or palmtops. A palmtop computer requires components that can be run from AA battery power, and the microprocessor manufacturers have responded with a process called **CMOS** (complementary metal-oxide semiconductor). CMOS components require far less power and generate far less heat than their corresponding non-CMOS components. This makes them ideally suited for battery-powered palmtop computers.

SUPERCOMPUTERS

Despite the widespread trend toward smaller and smaller computers, many tasks still require the processing of massive amounts of information at extremely high speeds. Examples include aircraft and automobile design, nuclear weapons development, weather prediction, computer animation, and many areas of basic scientific research. The computers that perform such tasks are called supercomputers because they are the fastest computers made and their performance far outpaces that of even the largest and most powerful mainframe computers.

Supercomputers are designed to perform different types of processing tasks than mainframes, so their speed is usually rated in gigaflops instead of MIPS. (A gigaflop is one billion floating-point operations per second). For example, the Thinking Machine CM-200 has a 9-gigaflop rating, and Intel's Touchstone Delta has an 8.6-gigaflop rating. By comparison, an IBM RISC System/6000 workstation has a 0.064-gigaflop rating.

The goal of supercomputer manufacturers is to reach teraflop (one trillion floating-point operations per second) speeds, which would be 1000 times faster than today's models. To achieve such processing speed, new processor technology, more processors and memory, and improved input/output operations will all have to be pushed far beyond today's state-of-the-art supercomputers.

Parallel processing. As designers of supercomputers experiment with technologies such as shrinking the circuits smaller and smaller and immersing the components in liquid coolants to keep them from melting, they are beginning to run up against fundamental limits on the speeds that can be achieved by conventional single-processor computers. A problem occurs when the single channel between one processor and memory, along which data and instructions must flow, limits the speed of the computer system.

Multiprocessing is the simultaneous processing of two or more portions of the same program by two or more processing units. One way to speed up computers is to divide the labour among multiple processors rather than continue the quest for ever-faster single processors made with more exotic materials and techniques. Many of today's large computers employ multiple processors. The Cray X MP 4 supercomputer uses four processors.

(The MP stands for multiple processors, and the 4 for the number of processors).

Parallel processing combines multiple microprocessors with software techniques that facilitate executing parts of a program in parallel. Parallel processing differs from multiprocessing in the way that a task is distributed over several processors. In parallel processing, a task is evenly distributed among the processors.

Massively parallel systems were once the exclusive domain of a relatively small cadre of scientists and engineers. However, developers of business applications, such as image processing and recognition, and decision-support and text-retrieval systems, are looking to massively parallel solutions to gain competitive advantage and to create new services for customers.

Although parallel-processor computers may eventually be more suitable than single-processor computers for many applications, the problem of using current software on parallel computers has yet to be solved. Simply throwing more processors at today's tasks does not mean that a job can be done better or faster. Software has to be changed to take advantage of parallel processing.

3.2. Translate the following word – combinations so that you could form compound nouns.

Вакуумна трубка, комп'ютерна промисловість, пристрій уведення, квант часу, масове виробництво, комп'ютерна анімація, прогнозування погоди, розвиток ядерного озброєння, методи програмного забезпечення, розпізнавання зображень, мікросхема на кремнієвій основі, кольорове зображення, комп'ютерні схеми, напівпровідниковий матеріал, відділ досліджень ринку, проектування автомобілів і літаків.

3.3. Find pairs of synonyms and antonyms.

Expensive, shrink, connect, rapidly, construct, decrease, collect, similar, major, request, multiple, wipe, generate, consume, record, respond, minor, single, different, distribute, increase, destroy, slowly, break, simple, enlarge, cheap, compress, sophisticated, dear, link, quickly, build, reduce, gather, various, important, numerous, erase, produce.

3.4. Complete the sentences with the most suitable words.

1. The computers that process massive amounts of information at extremely high speeds are called ____________ .
2. The term ____________ refers to a computer system that has become inoperable owing to an equipment malfunction or error in a program.
3. ____________ differs from multiprocessing in the way that a task is distributed over several processors.

4. Computer circuits have progressed from vacuum tubes to ____________ that are smaller than a fingernail, each containing over a million integrated circuits.
5. The application called scientific visualization vividly demonstrates the power and capability of today's ____________ .

3.5. Translate into English in writing.

Оскільки розміри транзисторів у мікросхемах нових поколінь постійно зменшуються, то і шар диоксиду кремнію повинен ставати все тоншим і тоншим. Проте товщина ізолюючого шару неухильно наближається до межі, за якою суттєво погіршуються електричні якості цього традиційного ізолятора напівпровідникових інтегральних схем.

Найбільш вдалу пропозицію для вирішення цієї проблеми зробили спеціалісти фізичної дослідницької лабораторії (PSRR, Physical Sciences Research Lab Motorola) – використовувати матеріал, який за своїми електричними властивостями схожий на диоксид кремнію, але має набагато менші фізичні розміри. Цей матеріал – титанат стронцію – відноситься до класу мінералів – перовскітів (perovskites).

Він має діелектричні показники, які перевищують диоксид кремнію більше ніж в 10 разів.

У лабораторії цей матеріал одержують штучно, нарощуючи атоми шар за шаром, що дає можливість одержати чисті і майже ідеальні кристали перовскітів.

Унікальні діелектричні характеристики дозволяють у 3-4 рази зменшити товщину елементарних транзисторів кристалу в порівнянні з використанням диоксиду кремнію.

Перспективи використання перовскітів дуже широкі. На їх основі можна проектувати напівпровідникові мікросхеми широкого вжитку з дуже низьким енергоспоживанням.

3.6. Answer the questions.

1. What breakthrough contributed to shrinking computer circuits?
2. What does VLSI mean?
3. What techniques for increasing the overall efficiency of computer operation do you know?
4. In what spheres is distributed computing applied?

5. What is scientific visualization used for?
6. Explain in your own words the term client/server computing.

Test Yourself

Match the following terms to the appropriate definition

A.

1. Peripherals
2. Processor
3. Instruction set
4. Clock
5. Control unit
6. Arithmetic/logic unit (ALU)
7. Register
8. Word size

a. The functional unit that is responsible for supervising the operation of the entire computer system.
b. A storage location inside the processor.
c. A timer in a processor that releases precisely timed signals that provide a pulse for the processor's work.
d. A functional unit that interprets and carries out instructions.
e. Devices, such as keyboards and display screens, that surround the processor and memory.
f. A unique set of operations that comes with every processor.
g. The term used to describe the size of operand registers and buses.
h. A functional unit that provides the computer with logical and computational capability.

B.

9. Memory
10. Random access
11. Bus
12. Virtual memory
13. Cache
14. Reduced instruction-set computer (RISC)
15. Semiconductor
16. Very-large-scale integration (VLSI)
17. Ultralarge-scale integration (ULSI)
18. Mainframe

19. Channel
20. Time-sharing

a. A technique for creating the illusion that a computer has more memory than it actually has.
b. A material whose electrical properties are less than a conductor and greater than an insulator.
c. A method of organization in which access time is the same for any location.
d. A small processor in a computer designed to handle input/output operations.
e. A circuit that provides the pathway for the transfer of information between two or more devices.
f. The sharing of a single processor switching back and forth among many
g. separate programs.
h. A technology that packs 100,000 to 100 million switches on each chip.
i. A large-scale computer used to process large volumes of data.
j. A high-speed memory that is sometimes built into the processor.
k. Hardware and software that reduces the number of instructions in a computer's instruction set and attempts to execute each instruction as quickly as possible.
l. A technology that packs 100 million to 1 billion switches on each chip.

C.

21. Minicomputer
22. Distributed computing
23. Microcomputer
24. Workstation
25. Scientific visualization
26. Client/server computing
27. Fault-tolerant computer
28. Supercomputer
29. Multiprocessing
30. Parallel processing

a. A computer with a CPU based on a microprocessor.
b. A computer that uses redundant components to prevent failure.
c. The combination of multiple processors and software techniques to-facilitate executing parallel instructions.

d. A medium-sized computer that is capable of many of the same functions as a mainframe computer.
e. A number of small computers distributed throughout an organization.
f. The simultaneous processing of two or more portions of the same program by two or more processing units.
g. The fastest computer made.
h. Distributing an application into cooperating parts that are independent of one another.
i. A high-end computer for applications requiring considerable calculating and graphics capability.
j. Image-processing techniques used to interpret and visualize data captured by cameras and sensors.

True/False:

31. Processors come with a unique set of operations called an instruction set.
32. In an instruction, operands specify the function to be performed.
33. A processor's job is to retrieve instructions from memory and perform step-by-step operations.
34. The control unit is the functional unit that provides the computer with logical and computational capabilities.
35. A logic operation is one that makes a comparison and takes action based on the results.
36. The size of a computer's registers affects the speed and performance of a processor.
37. Digital signal processors relieve the central processor of intensive numeric calculations.
38. Random access is accomplished by arranging memory in an array that is similar to a spreadsheet.
39. The miniaturization of electronic circuits is an important trend in the evolution of computers.
40. The early mainframe computers were high-volume, mass-produced computers.
41. Making a computer circuit faster requires bigger chips.
42. Microcomputers eventually became a cost-effective replacement for minicomputers.
43. Applications that perform batch processing are prime candidates for fault- tolerant computers.
44. The goal of supercomputer manufacturers is to reach gigaflop (one billion floating-point operations per second) speeds.

45. Newer designs for computers are incorporating a number of multiple processors linked together.

Multiple Choice:

46. Which of the following is not a part of the central processing unit?
    a. Control unit.
    b. Arithmetic/logic unit.
    c. Memory.
    d. Registers.
47. The arithmetic/logic unit is responsible for
    a. Decoding instructions.
    b. Adding.
    c. Fetching data from memory.
    d. Control signals.
48. ROM can be used to
    a. Store the results of processing.
    b. Store parts of the operating system.
    c. Store programs and data.
    d. Store any kind of data a program needs.
50. Which of the following is not a bus found in the central electronic complex?
    a. Instruction.
    b. Control.
    c. Address.
    d. Data.
51. Which of the following is not a common word size in microprocessors?
    a. 16 bits.
    b. 32 bits.
    c. 64 bits.
    d. 128 bits.
52. Virtual memory
    a. Is a larger and faster memory.
    b. Consolidates pieces of a program.
    c. Creates the illusion of more memory.
    d. None of the above
53. One of the first breakthroughs in efficiency for mainframe computers was to
    a. Build fault-tolerant computers.
    b. Engage in multiprocessing.

c. Engage in parallel processing.
d. Build in separate processors for input and output.

54. Which of the following is not a technique for increasing computer speed?
    a. Shrinking circuits.
    b. Fault-tolerant design.
    c. Cooling circuits.
    d. Parallel processing.
55. A major problem with parallel processing is
    a. Combining hundreds to thousands of microprocessors.
    b. Simultaneous processing by multiple processors.
    c. Using today's software.
    d. All of the above.
56. Supercomputers currently have speeds rated in
    a. Megaflops or one million floating-point operations per second.
    b. Gigaflops or one billion floating-point operations per second.
    c. Teraflops or one trillion floating-point operations per second.
    d. None of the above.