**Exercises**

**1 . Please think from the functional side and briefly explain what a computer is in one sentence.**

**Sol:** A machine that accepts specific instructions and executes them in a predetermined manner or logic.

**2 Please list 3 types of computer classification according to different perspectives.**

**Sol:** 1. Classification according to the scope of application

2. Classification by the type of data being processed

3. Classification according to processing energy

**3 If classified according to the scope of application, according to the versatility of computers, what are the two categories of computers?**

**Sol:** 1. general purpose computer

2. Special purpose computer

**4 If classified according to the type of data processed, what are the three categories of computers?**

**Sol:** 1. Digital computer

2. Analog computer

3. Hybrid Computer

**5 If classified according to processing energy, what are the 5 types of computers that can be roughly divided into?**

**Sol:** 1. Super computer

2. Mainframe computer

3. Medium computer

4. Mini computer

5. micro computer

**6 If classified according to the use occasion, what are the three categories that computers can be divided into due to their placement or work location?**

**Sol:** 1. server

2. Desktop Computer

3. embedded computer

**7 Please try to explain the five important eras of modern computer development and describe the characteristics of each generation.**

**Sol: 1. The Origin of Electronic Computers - The Age of Mechanical (1642~1945):**

* + In the early days of computer development, most of them were used for arithmetic purposes, and their common feature was that they all operated by mechanical devices.
  + It has a fairly complex structure, but due to the limitations of its drive method, it still cannot provide truly "high-speed" computing power.

**2. The First Generation of Computers - The Vacuum Tube Era (1946~1953):**

* The generation that switched from mechanical drive to electric power. Among them, the use of vacuum tubes is the most important change of this generation.
* Vacuum tubes are costly, less durable, bulky, and inefficient.
* Since vacuum tubes are not very suitable for building computers, the stability of computers is very poor.

**3. The Second Generation of Computers - The Transistor Era (1954~1965):**

* Transistors, with their small size, better heat dissipation, and fairly reliable electronic characteristics, quickly replaced vacuum tubes as the basic components of computers.
* It breaks down the limitations that computers are expensive and cumbersome, and the units that can use computers are no longer just government agencies, universities, and mega-enterprises.

**4. The Third Generation of Computers - The Era of Integrated Circuits (1965~1980):**

* Compared with conventional circuit combinations that are scattered on the circuit board and connected by copper wires, the signal and current conduction speed inside the IC is much faster, hundreds, thousands, or even more times, so it can greatly speed up the operation of the entire computer.
* The materials used are more streamlined, and the process technology continues to advance, and the cost of computers continues to decrease.
* The number of transistors that can be accommodated is increasing, and the internal systems are getting larger and larger, almost all of which show an order of magnitude of growth such as multiples of 10.
* The number of transistors contained in integrated circuits has almost become the standard for evaluating the overall performance of computer processing chips.

**5. The Fourth Generation of Computers - VLSI Era of Very Large Integrated Circuits (1980~Now):**

* Higher transistor density represents faster and more powerful chips. The various computer processors we see today are all products after the VLSI era.
* At present, the development of integrated circuits has further entered the era of so-called nanometers, and more precise processes, smaller chips, and more transistors are believed to bring us more powerful and efficient processors.

**8 List the five main components of a computer system, briefly explain the functions of each component, and illustrate the cooperation between each component.**

**Sol: 1. Memory Unit:**

* The memory unit is the place where the computer stores data and programs, and all the data required by the CPU is provided by memory, and the processing results are also stored back in memory first.
* Storage devices are also known as auxiliary memory or secondary memory; At present, the main memory is usually directly referred to as "memory".

**2. Input Unit:**

* The main function of the input unit is to read external programs and data and store them in the main memory.

3. **Arithmetic & Logic Unit（ALU）：**

* The Arithmetic and Logic unit is a part of a computer's central processing unit (CPU) that is responsible for performing various operations and processing data.
* The two most important tasks of ALU are arithmetic operations (addition, subtraction, multiplication and division) and logical operations (AND, OR, NOT).
* Since the ALU is the place where the data is actually processed, and the data in the process is computed through registers, the ALU, registers, memory, and the data transmission channel between them are collectively referred to as the data path of the computer.

**4. Output Unit**

* The output unit is responsible for taking the results of the central processing unit's operations out of the main memory and making them available to the user in various forms.

**5. Control Unit (CU）**

* It is composed of a bunch of control circuits scattered throughout the computer, responsible for the command, coordination, and control of the computer system, as well as the decoding of instructions.
* The CU generates various timing signals to each unit according to the needs of the program instructions, so that each unit can complete the work it should complete at the right time to correctly implement the execution of various computer programs.



**9 List the seven levels of computer operation architecture and briefly describe the functions and characteristics of each level.**

**Sol: Tier 7: User tier layer**

* The user layer is a layer that directly faces the user, that is, the layer closest to "people".
* The user hierarchy is the highest level of the entire computer architecture, providing a convenient interface for people to use, and all assigned tasks are directly issued by the user.
* The computer interface faced by ordinary users is actually the various applications provided by the user layer.

**Level 6: Advanced language layer**

* How applications are generated and how they function correctly is done through what is called high-level language.
* High-level language is a computer language similar to human language, and its language logic is similar to human thinking, so it is represented by "high-level".
* Programs written in high-level languages are called source code, and computer systems must be able to perform the correct actions exactly according to each command given by the high-level language.
* High-level languages that are more familiar to the general public include C, C++, C#, Java, Visual Basic, etc.

**Level 5: Assembly language layer**

* Computer systems divide the command actions of higher-level languages into simpler actions and describe them in a language that the computer can recognize, and this language that is more "close" to the computer is called assembly language.
* It is not easily understood by humans and is generally classified as a low-level language.
* Assembly language programs of computers with different architectures are not compatible with each other.

**Level 4: System program layer**

* It includes an operating system that directly controls computer hardware, an assembler that converts assembly language into machine language, and a program that links and loads machine language programs into memory and manages their execution.

**Level 3: Machine layer**

* Since computer hardware can only accept very simple instructions, the machine language code is further disassembled into smaller machine instructions that the computer can directly execute, and the collection of all machine instructions is called its Instruction Set (IS).
* The type and format of the command will affect the cycle of command execution, the encoding of the instruction format, and the addressing mode of the command.
* The most critical issue in computer organization and structural design is actually how to design and implement instruction sets with hardware.

**Level 2: Control layer**

* The overall operation of the computing unit is coordinated by the control unit (CU) in the CPU.
* Reliable hardware wiring (hardwired) or micro instructions written as microprograms.

**Level 1: Digital logic layer**

* What you see in this hierarchy is the actual basic circuit components of the computer processor.
* The number and strength of computer functions determine the complexity of the circuit, which is designed in the form of digital logic.

**10 What are the benefits of dividing the computer operating architecture into seven layers for computer design?**

**Sol:** Each of the seven layers can be used independently to fully describe the function or operation of a computer, but changes in either layer do not affect the contents of the two layers above and below. Therefore, designers can easily solve the computer in a hierarchical way: each level can get a set of answers to the problem, and then hand over this solution to the next level for processing or implementation until the lowest level problem is solved, and finally integrate these individual solutions from the bottom up.

**11 Please try to explain what Moore's Law is and what impact does it have on the development of the computer industry?**

**Sol: Moore's Law:**

* Electronic computing components are shrunk and integrated into integrated circuits, commonly known as microchips, and the computing power of the chips can double every year.
* In fact, the IC industry has achieved about "doubling every 18 months", so the current generally recognized cycle is 18 months.
* Moore's Law involves the economic benefits of developing and producing ICs. Because the cost of important equipment in the semiconductor industry is predicted to triple every four years, the industry can only survive if Moore's Law continues to hold.

**12 The figure below shows the growth of the number of transistors in the production processor, please explain whether it complies with Moore's law**



**Sol:** Complies with Moore's Law. The slash line in the figure represents the trend curve of doubling the number of transistors after about a year and a half, and the growth distribution of the number of processor transistors is roughly located on this curve, so we can know that the growth of the number of processor transistors is in line with Moore's law.

**13 Please illustrate the relationship between high-level language, low-level language, and machine language in the form of icons, and explain the process of program translation at each stage.**

**Sol: High-level language:**

Programs written in high-level languages are called source code, and computer systems must be able to perform the correct actions exactly according to each command given by the high-level language.

**Low-level languages:**

The source code of high-level languages cannot be executed directly; Because high-level language commands are more complex, computer systems must divide them into simpler actions and describe them in low-level language that is closer to the basic actions of the computer, more streamlined, and has a syntax that is closer to that the computer can understand.

**Machine Language:**

After being translated into assembly language, program instructions cannot be executed directly, and must be translated into machine language that the computer can only understand, that is, machine code composed of only 0 and 1 before it can be executed.

**High-level**

**language**

**Low-level languages**

**Machine**

**Language**

**14 Briefly explain what the Van Neumann architecture is. What is the Van Neumann bottleneck?**

**Sol: Van Neumann Architecture:**

Also known as internal storage program architecture. Through the design of the instruction set, the program becomes a process of execution of a series of commands. At the same time, these sequences of instructions are stored in the computer's memory along with the data, so that the program can be easily modified as the data and executed under the existing hardware architecture.

**Van Neumann Bottleneck:**

Because the CPU is separate from memory, the programs executed by the CPU and the data processed are placed in memory. However, the speed of obtaining data or instructions from memory is usually slower than that of CPU, so when a program needs to retrieve data from memory during execution, it may affect the overall performance of the program.

**15 Please refer to the development process of Intel microprocessors, and try to speculate that with the advancement of integrated circuit process technology, processors consume less and less power, but why do most processors need to use cooling fans?**

**Sol:** As the number of transistors grows rapidly in compliance with Moore's Law, the power consumed by a large number of transistors in the microprocessor also increases rapidly, so cooling fans are needed to assist in heat dissipation.

**16 What is a command set computer? How does such a concept help or benefit computer design?**

**sol: instruction set computer:**

* An electronic computer that integrates all hardware operating circuits is called an instruction set computer.
* It is easy to control the computer with programmed hardware circuits, making it more flexible to use.

**17 According to the complexity of computer instruction sets, what are the two categories of computers?**

**Sol:** 1. Reduced Instruction Set Computer，RISC）

2. Complex Instruction Set Computer，CISC）