МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

**Федеральное государственное автономное образовательное учреждение выcшего образования**

«**Национальный исследовательский Нижегородский государственный университет**

**им. Н.И. Лобачевского**»

**Reading and Comprehension**

Учебно-методическое пособие

Рекомендовано методической комиссией ИФИЖ ННГУ для студентов ИТММ

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Настоящее пособие предназначено для студентов, обучающихся по профилю бакалавриата и магистратуры ИИТММ ННГУ. Оно может быть использовано как для аудиторной, так и для самостоятельной работы. Тексты пособия рассчитаны на тренировку труднопроизносимых слов, привитие навыков перевода и правильного понимания оригинального текста, обогащение словарного запаса студентов, развитие речевых и письменных навыков, а также навыков самостоятельной работы над книгой с различными словарями и справочниками.

Тексты подобраны с учетом профессиональной ориентации студентов и призваны обеспечить:

1) Контроль понимания прочитанного;

2) Запоминание и частичную активизацию лексических единиц в текстовом и концептуальном значении;

3) Умение вести беседу-дискуссию.

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## COMPREHENSION EXERCISES

Questions

1. What can (can's) computers do? 2. Are computers slaves or masters? Who is really giving orders: man or machine? 3. Can we tell a computer how to learn, to create, to invent, etc.? 4. How can a machine be made to decide? 5. How can one determine whether or not a problem can be solved by a computer? 6. Why is the road from the conception of a programme to its execution by the computer so long and tiresome? Why is the software so costly and unsatisfactory? 7. What are we really trying to do in the process of communication? 8. What human abilities are irreplaceable by a computer? 9. Why is the number of possible computer designs limitless? 10. Is there any limit to computer speed? 11. What enables modern computers to operate in millions of a second? 12 How can current computers be applied to the problem of computer science itself? 13. What is the role of the programmer in the transition of meaningful information to the strings of meaningless bits (information in the computer sense) with which a computer operates? 14. What results can be achieved by performing a sharply defined sequence of sharply defined actions? 15. Can a programmer be dispensed with in the modern supercomputers programming? 16. What is known about natural intelligence? 17. When can we justifiably call a machine intelligent? 18. How and to what extent do computers currently simulate intelligence or display intelligent behaviour? 19. How can machines eventually simulate intelligence? 20. How can machines and their behaviour be described mathematically? 21. Has the ambition of A. I. researchers to programme the computer to do the translating job itself been realized? 22 What uses can be made of intelligent machines? 23. Can a computer attain the cultural level of a child? 24. Why has this question divided all specialists into two "for" and "against" camps? 25. Does humour play any role in human thinking? 26. Can a computer be programmed to produce humour? 27. Are files containing personal information within easy access? 28. Is information about people's private lives in the US increasingly vulnerable to interception and misuse? 29. Is it because of the spread of computers as record keepers? 30, Are job applicants forced to take lie-detector tests in the USSR? 31. Will anyone's privacy be protected in future?

Discussion

1. The history of computation and computing devices: finger reckoning the abacus early computers current microcomputers and supercomputers. The rise of computers has been called "The Second Industrial Revolution", but it is far more than that. Explain. 3. Man and computer are able of accomplishing things that neither of them can do. Prove it. 4. The difference between Cybernetics in theory and in practice. 5 N. Weiner's the father of Cybernetics "Cybernetics Is Control and Communication in the Animal and the Machine" (1948) is still generally accepted despite the appearance of other definitions of various lengths and complexity. Why? Concentration of large amount of circuitry into a small volume to minimize the length of wires creates a serious problem: the removal of the waste heat generated by electrical energy conversions. How is this problem being solved? 7. Speed with which signals can be propagated or transferred from one part of the computer to another is an important feature of a computer. Why? 8. Digital circuits are subject to errors caused by the failure of the computer components and by random electrical noise. What should be done to reduce errors to your mind? 9. To err is human. Even when people do try, they make mistakes. It is impossible to be always perfectly accurate. If your pride cannot reconcile with this fact, you will never make a good programmer. Agree or disagree. 10. Communications between a computer and the outside world referred to as input-output (1/0) operations are very slow in relation the computer's internal processing speeds because peripheral devices have mechanical components and human response time is slow. Are any modifications in this area possible? 11. Much effort is currently being given to the reexamination of algorithms for large computational problems aiming to maximize the number of operations that can be carried out concurrently in the generation of supercomputers and with the help of new programming languages. Have any advance and progress been achieved in this field of research? 12. "The language of the brain is not the language of mathematics" J. V. Neumann. Discuss the difference between the mathematical mind, the perception mind, the computer mind 13. "Why does Cybernetics- this magnificent applied science which saves work and makes life easier bring to us so little happiness? The simple answer runs: Because we have not yet learned to make sensible use of it" (A. Einstein). Agree or disagree. 14. Computers have permeated our society. No educational institution, research lab., large bank, insurance company can survive today without using computers. Is it really the case? 15. The mastery of handling a calculator, personal computer, sophisticated computer techniques of calculation ought to become one more compulsory educational task for every person nowadays. Universal computer science competence and skillfulness (компьютерная грамотность) is the nearest future reality.

Agree or disagree.

16. The power of computers can be used for good and evil. Illustrate both, Computers, cable television and electronic-banking devices which make life easier for many persons also help intruders gain access to private data. US Federal bureaucrats maintain a mass of dossiers and other lies on citizens to track their behaviour and conduct. Amateurs, too, use equipment sold without restriction to bug a neighbour with tiny microphones and transmitters. The world in which all statements are "on the record" is frightening to contemplate. Your viewpoint on the relentless march of technology and threats to privacy in the United States 17. "We may hope that machines will eventually compete with man in all purely intellectual fields" (A. M. Turing, 1950). Was Turing right? 18. C. E. Shannon, the inventor of Information Theory said: "Efficient machines for such problems as pattern recognition, idiomatic language translation, etc, may require a different type of computer that any have today. It is my feeling that this will be a computer whose natural operation in terms of patterns, concepts, and vague similarities rather than sequential operations on numbers". Your viewpoint. 19. The software triad: MATHEMATICAL MODEL - ALGORITHM-PROGRAMME. The significance of each component and of the three taken together. Mathematical modelling. Computing experiment. What do these phrases mean? How can one construct a mathematical model to represent an object (system, process, phenomenon) under study? Scientific experimenting on the computer- is it a dream or today's practice? It was in the Soviet Union that the first mathematical model of "nuclear winter" was designed and computed. The integration of mathematical modelling and effects in science and industrial production. designing computing experimenting. Its aims 20. The contribution .of Cybernetics to: a) Modification of human mentality and scientific thinking; b) Accelaration of scientific and technological progress; c) Modernisation and updating of industry; d) Restructure of the management system; e) Crash Changes in economy to double productive output; 1) Implementation of large-scale integrated programmes in the strategic areas; g) Application of intensive technologies in agriculture; h) Advance in socio-economic development of the Soviet society; i) All-embracing international security system building. 21. The first world conference in Artificial Intelligence was held in 1956. All the participants agreed to adopt the term "A. I." to qualify their field of research. They disagreed on the means and routes to attain their cherished goals. The scope and limits of A. I. research. 22. The basic problem facing workers attempting to use computers in the simulation of human intelligent behaviour is now clear: all alter- natives must be made explicit. Is it possible? 23. Many ambitious research projects were launched with the goal of clearly demonstrating the learning capabilities of computers so that they could translate idiomatically, carry on free and natural conversations with humans, recognize speech and print it out, diagnoze diseases, etc. All these activities demand human qualities. What are the current achievements in all these fields? 24. The field of A. I. exhibits a recurring pattern: early dramatic success followed by sudden unexpected difficulties and failures. This pattern occurs in all basic areas of A. I. (problem-solving, game-play- pattern, language-translation and pattern-recognition) in two phases, each lasting roughly five years. The reasons, to your mind? 25. In spite of grave difficulties and failures A. I. enthusiasts are not discouraged, in fact they are optimistic. They claim: "Computers will be able, within ten years of doing any work that a man can do". There must be a reason why they continue dogmatically to assert their faith in the progress. Your viewpoint. 26. The formalization of intelligent human behaviour must be possible as well as computers capable of communicating with people in common language. Agree or disagree. 27. Man is building more and more powerful machines but remains their slave as he has to control them. Coordination will be left to the machine itself in the future. Such predictions may belong to the realm of science fiction, or are these claims possible and realizable in practice? 28, The Third Industrial Revolution looms on the horizon. It will be brought about by the development of machines free from human control and its limitations, and capable of thinking for themselves, and organizing themselves into autonomous breeding units. When will this happen?

## II. History of the terms “ellipse”, “hyperbola”, and “parabola”

The evolution of our present–day meanings of the terms “ellipse”, “hyperbola”, and “parabola” may be understood by studying the discoveries of history’s great mathematicians. As with many other words now in use, the original application was different from the modern.

    Pythagoras (c. 540 B.C.), or members of his society, first used these terms in connection with a method called the “application of areas”. In the course of the solution (often a geometric solution of what is equivalent to a quadratic equation) one of three things happens: the base of the constructed figure either falls short of, exceeds, or fits the length of a given segment. (Actually, additional restrictions were imposed on certain of the geometric figures involved.) These three conditions were designated as ellipsis (“defect”), hyperbola (“excess”) and parabola (“a placing beside”). It should be noted that the Pythagoreans were not using these terms in reference to conic sections.

   In the history of conic sections, Menaechmus (350 B.C.), a pupil of Eudoxus, is credited with the first treatment of conic sections. Menaechmus was led to the discovery of the curves of conic sections by a consideration of sections of geometrical solids. Proclus in his summary reported that the three curves were discovered by Menaechmus; consequently, they were called the “Menaechmian triads”. It is thought that Menaechmus discovered the curves now known as the ellipse, parabola and hyperbola by cutting cones with planes perpendicular to an element and with the vertex angle of the cone being acute, right or obtuse respectively.  
   The fame of Apollonius (c. 225 B.C.) rests mainly on his extraordinary “Conic Sections”. This work was written in eight books, seven of which are preserved. The work of Apollonius on conic sections differed from that of his predecessors in that he obtained all of the conic sections from one right double cone by varying the angle at which the intersecting plane cuts the element.

   All of Apollonius’ work was presented in regular geometric form, without the aid of algebraic notation of present day Analytical Geometry. However, his work can be described more easily by using modern terminology and symbolism. If the conic is referred to a rectangular coordinate system in the usual manner with point A as the origin and with (x,y) as coordinates of any points P on the conic, the standard equation of the parabola y2=px (where p is the length of the latus rectum, i.e., the length of the chord that passes through a focus of the conic perpendicular to the principal axis) is immediately verified. Similarly, if the ellipse or hyperbola is referred to a coordinate system with vertex at the origin, it can be shown that y2<px or y2>px, respectively. The three adjectives “hyperbolic”, “parabolic”, and “elliptic” are encountered in many places in maths, including projective geometry and non–Euclidean geometries. Often they are associated with the existence of exactly two, one, or more of something of particular relevance. The relationship arises from the fact that the number of points in common with the so called line at infinity in the plane for the hyperbola, parabola and ellipse is two, one and zero respectively.

## III. Analytic geometry

   The rectangular coordinate system provides a one-to-one correspondence between number pairs and points; that is, corresponding to a number pair (X1, Y1) there is always one and only one point P1; and corresponding to a point P2 there is one and only one number pair (X2, Y2). This one-to-one correspondence is the starting point of the plane Analytic Geometry.

   The notion of correspondence between a point in the plane and a pair of numbers can be extended to a more general kind of correspondence, namely, between a geometric locus and an equation. The graph of an equation is the locus of the points whose coordinates satisfy the equation. Conversely, the equation of a given curve is an equation satisfied by the coordinates of every point on the curve and by the coordinates of no other points.

   This correspondence between equations and geometric loci, will indeed, form the central subject of our study. That is to say, our main investigation will take the form of one or the other of the problems:

1. Given an equation, to obtain the corresponding geometric locus (the graph of the equation) along with its properties.
2. Given a geometric locus whose points possess some common property (shared by no other points), to find the corresponding equation.

   In the latter case the equation, in turn, will help us in studying other properties of the locus.

   Thus, we define a curve as composed of points whose coordinates satisfy a certain equation. We may think of a curve as a locus or a path traced by a moving point according to certain specified conditions. From these conditions it is possible to derive the equation of its curve and then discuss the curve in detail from the equation. The locus of an equation in X and Y is defined as the totality of points whose coordinates satisfy the equation. These exists no definite rule for finding the equation of the locus. As a matter of fact the problem is to translate the geometric definition of the locus into an algebraic form with a suitable choice of a coordinate system.  
   We shall proceed to the discussion of particular species of loci – namely, the straight line, a circle, a parabola, an ellipse, and a hyperbola.

   The problem of finding the equation of the straight line is the simplest case of the general problem of finding the equation of a curve. The equation of a straight line is determined by two points P1(X1, Y1) and P2(X2, Y2). This equation will be obtained from the fact that the point P(X, Y) is on the straight line, if and only if, the slopes of the segments P1 P and P1 P2 are equal. This condition is (Y – Y1)/(X – X1) = (Y2 – Y1)/(X2 – X1), X1 ≠ X2. We shall refer to this as the two-point form of the equation of the straight line. Thus any straight line may be represented by an equation of the first degree in X and Y. Conversely, every equation of first degree Ax + By + C = 0 represents a straight line.

   The following loci lead to particular type of second degree equations, in two variables.  
   The Circle is the locus of a point, which moves so that its distance from a fixed point, called a centre, is constant. The distances from its centre to the locus are radii of the circle. Thus, x2 + y2 = r2 the equation of the circle with the centre at the origin and radius r.

   The Parabola is the locus of points which are equidistant from a fixed point and a fixed straight line.

   The fixed point is the focus, the fixed line is the directrix. The line perpendicular to the directrix and passing through the focus is the axis of the parabola. The axis of the parabola is, obviously, a line of symmetry. The point on the axis halfway between the focus and the directrix on the parabola is the vertex of the parabola. The equation of the parabola, however, depends on the choice of the coordinate system. If the vertex of the parabola is at the origin and the focus is at the point (O, P) its equation is X2 = 2PY or Y2 = 2PX.

   The Ellipse – is the locus of a point which moves so that the sum of its distances from two fixed points called the foci is constant. This constant will be denoted by 2a, which is necessarily greater than the distance between the foci (the local distance). The line through the foci is principal axis of the ellipse; the points in which the ellipse cuts the principal axis are called the vertices of the ellipse. If the centre of the ellipse is at the origin but the foci are on the y-axis its equation is Y2/a2 + X2/b2 = 1, where a and b represent the lengths of its semimajor and semiminor axes.

   The Hyperbola is the locus of a point which moves so that the difference of its distances from two fixed points is a constant 2a. Its equation is x2/a2 – y2/b2 = 1. This equation shows that the hyperbola is symmetric with respect to both coordinate axes and also the origin. It intersects the X-axis but does not cut the Y-axis. Hence, the curve is not contained in a bounded portion of a plane. The curve consists of two branches. The line segment joining the vertices is called the transverse axis of the hyperbola; its length is 2a. The point midway between the vertices is a geometrical centre and called the centre of the hyperbola.

## IV. Artificial Intelligence

Are we intelligent enough to understand intelligence? One approach to answering this question is **Artificial Intelligence** (A.I.), the field of computer science that studies how machines can be made to act intelligently. “Artificial intelligence” is the ability of machines to do things that people claim require intelligence. A.I. research is an attempt to discover and describe aspects of human intelligence that can be simulated by machines. For example, at present there are computers that can do the following things:

1. Play games of strategy (e.g. Chess, Checkers, Poker) and (in Checkers) learn to play even better than people.
2. Learn to recognize visual or auditory patterns and perform image processing.
3. Find proofs for mathematical theorems.
4. Solve certain, well-formulated kinds of problems.
5. Process information expressed in human languages, etc.

The extent to which computers can do these things independently of people is still limited; machines currently exhibit in their behaviour only rudimentary levels of intelligence. Even so, the possibility exists that machines can be made to show behaviour indicative of intelligence, comparable or even superior to that of the humans. Alternatively, A. I. research may be viewed as an attempt to develop a mathematical theory to describe the abilities and actions of things (natural or man-made) exhibiting “intelligent” behaviour, and serve as calculus for the design of intelligent machines. As yet there is no “mathematical theory of intelligence”, and researches dispute whether there ever will be. A. I. is also the study of ideas which enable computers to do the things that make people seem intelligent. But then, **what is human intelligence**? Is it the ability to reason? Is it the ability to acquire and apply knowledge? Is it the ability to manipulate and communicate ideas? Surely all of these abilities are part of what intelligence is, but they are not the whole of what can be said. Indeed a definition in usual sense seems impossible because intelligence is an amalgam of so many information-processing and information-representation talents.

Nevertheless, one can define the goals of the field of A.I. . **The central goals of A.I. are to make computers more useful and to understand the principles which make intelligence possible.** Since one goal is to make computers more useful, computer scientist and engineers need to know how A.I. can help them solve difficult problems. And since the other goal is to understand general intelligence better for its own sake, psychologists, philosophers, linguists, and other people who want to understand human intelligence also need to know and evaluate what is learned. A.I. enthusiasts believe that using computers to understand central issues and the dimensions of intelligence is a powerful addition to the traditional methods of social sciences, psychology, philosophy and linguistics. There are some reasons for their commitment viz., computers are ideal experimental subjects: they exhibit unlimited patience, they require no feeding. Moreover, it is usually simple to deprive a computer programme of some piece of knowledge in order to test how important that piece really is. It is impossible to carve up animals’ brains with some precision. Computer models are precise and enable more powerful thinking about thinking.

Note that wanting to make computers **be** intelligent is not the same as wanting to make computers **simulate** intelligence. A.I. excites people who want to uncover principles that apply to all intelligent information processors, not just those that are made of wet nervous tissue instead of dry electronic gadgetry. Consequently, there is neither the obsession with mimicking human intelligence nor a prejudice against using methods that are involved in human intelligence. The overall result is a new point of view which brings along a new methodology and leads to new theories. One result of their new point of view may be ideas about how to help people become more intelligent. Just as psychological knowledge about human information processing can help make computers intelligent, theories observed purely with computers in mind often suggest possibilities for how to educate people better. Said another way, the methodology involved in making smart computer programmes may transfer to making smart people.

The classical experiment proposed for determining whether a machine possesses intelligence on a human level is known as **Turing’s test**, after A. M. Turing, who pioneered research in computer logic, undecidability theory and A.I. . This experiment has yet to be performed seriously, since no machine yet displays enough intelligent behaviour to be able to do well in the test. Still Turing’s test is the basic paradigm for much successful work and for many experiments in machine intelligence. Basically the test consists of presenting a human being *A* - human interrogator with a typewriter-like or TV-like terminal, which he can use to converse with two unknown (to him) sources, *B* and *C*. The interrogator *A* is told that one terminal is controlled by a machine and the other terminal is controlled by a human being he has never met. *A* is to guess which of *B* and *C* is the machine and which is the person. If *A* cannot distinguish one from the other with significantly better than 50% accuracy, and if this result continued to hold no matter what people are involved in the experiment, the machine then, it is claimed, **simulates** human intelligence.

It is clear that the intellectual capabilities of a human being are directly related to the functioning of his brain. Surprisingly little is known concerning the limitations of human intelligence. No one has made any complete survey of the problems that can be solved by human beings. The ability to solve certain types of problems has been studied and made the basis of “intelligence” tests, but generality and validity of these tests is disputable. I. Newton, for example, might have scored low on such tests when he was an adolescent; yet he is estimated by some researchers to have had an **Intelligence Quotient** (I. Q.) near 200. One of the shortcomings of these tests is that they predict little concerning the development of a person’s intelligence, especially what problems he could learn to solve What is **natural intelligence**, after all? Many definitions of “intelligence” may be summarized in one phrase, viz., **“intelligence” is the ability to “act rightly, in a given situation”**. Although one can imagine an entity that always behave “rightly”, without making any errors, A.I. research is more concerned with the concept of partial success with building machines that can make mistakes, but which can also change their behaviour with time and perhaps stop making mistakes. Intuitively, A.I. research is concerned with building machines that can “adjust” or “adapt” to certain environments, and which in effect **learn to solve problems** within these environments. This corresponds with the ordinary conception of human intelligence - that it is limited, but that it can learn and thereby improve its performance of certain tasks with time.

## V. Computer-Based Information Search

Today the computer has made locating, gathering, and analyzing data much faster and *cost-effective.* Even individual who owns a good computer and a modem can access *databases* and conduct in-depth intelligence searches that in the past only large corporations and libraries could afford.

Nowadays, using public and specialized online computer databases, one researcher can accomplish what formerly took the entire department far longer to accomplish. Some of the hardware required for efficient computerized searches include a modem, fax machine, and high-speed printer. The faster the transmission mode, the more efficient your *research* is likely to be.

**The Internet**

Many electronic network systems were created in 1989 and have continued to grow since then. They now offer *access to information* and the means to *communicate* with their other individuals, businesses, or countries all over the world. A tremendous amount of pertinent information is available on what is termed the Internet. In fact, you do not even have to leave your computer to obtain information from the world famous libraries.

The Internet is a global computer network. It is developing very rapidly. You can read many publications (newspapers, magazines, journals) through the Internet. E-mail is the most popular service. A great many of people, who have access to the Internet, use the network only for sending and receiving E-mail messages. In many countries the Internet provides businesspersons a reliable alternative to the more expensive and unreliable telecommunications systems. That is always cheaper, because you send E-mail messages, you only have to pay for phone calls to your local service providers, not for calls across your country or around the world. For these services you pay your service provider a monthly or an hourly fee. Part of this fee goes towards its costs to connect to a larger provider, another part received by the larger service provider goes to cover its costs of running a worldwide network of wires and wireless stations.

Internet services combine the use of audio, video, graphics, and text for procuring information. If the topic of your paper is NAFTA, and you have narrowed this down to an update on the North American Trade Agreement, it is possible to gather material through an Internet service. When you enter this term, you might found dozens of *sources*. Therefore, you must make choices to narrow down your topic as you work.

However, the Internet is considered *unreliable source of information*. It is very important as you use the Internet to keep in mind the thesis of your research. Because it is so easy to gather information and nothing guarantees its quality and accuracy, the writer must not become distracted and must be the final judge of the facts obtained. Another problem is its insecurity. When you send an E-mail message to someone, it travels through many different networks and computers. The information is constantly being directed towards its destination by special computers called *routers.* So it is possible to intervene into any of the computers along the route, read and even change the data being sent on the Internet. That is why you cannot send original contracts, letters of credit, invoices and other important documents through the Internet. However, these commercial and technical problems must be resolved in the nearest future.

Another popular Internet application is World-Wide Web. The number if Web-pages is hundreds of millions. There is a searching system to find the proper Web-page. Such a page contains a short description of a subject (program, institution, etc.) and the reference to other Web-documents.

**Home Computer and the Internet**

Availability of a home computer along with an on-line service could be very helpful. That involves installation and a monthly charge for the use of an on-line service. These charges are computed on the basis of time, however they are not computed according to the distance to your contacts. Therefore, the opportunities offered by having a home computer with on-line services may be cost-effective.

**Electronic Mail and How to Use It**

Electronic mail (E-mail) combines the advantage of writing with the *responsiveness* of the telephone. E-mail systems turn computers into in-boxes. As quickly as the term E-mail was established, the ability to communicate with different libraries and countries has increased through linking it to an electronic network such as Internet. E-mail is used widely for internal and external messages and suits itself particularly well to short informal messages. Increasingly, organizations are adopting e-mail as the primary mode of internal communication. Some organizations have policies in place that treat e-mail as a business asset, not a personal asset; thus from a legal perspective, e-mail is an admissible in court.

All you need to get started in E-mail is access to a computer with the right hardware, the appropriate software, and an E-mail address.

**Guidelines for using E-mail:**

* You will need to arrange for an E-mail address.
* Learn to write E-mail headings.
* Learn to write the body of the message entering it directly on the keyboard.
* Users of E-mail often use special abbreviations and emoticons to make their points.

In writing E-mail messages, you can depart from common writing conventions, but make sure that the speed the technology provides does not cause you to become careless. Veteran users of e-mail offer the following suggestions and cautions.

* Address one topic per e-mail message.
* Write an informative subject line.
* Keep screen length in mind when organizing.
* Make it easy for your reader to respond.
* When you respond to an e-mail message, include the context in your reply.
* Be concise.
* Re-read your message in various tones of voice to prevent misunderstandings.
* Don’t forget that many people may read your message.
* Don’t be too quick to push the “Send” button.
* Don’t send highly confidential messages.
* Realize that e-mail cannot fully replace the need for other forms of communication.

II. Ответьте на вопросы:

1. What are the main sources of information nowadays?
2. What are advantages of using the computer?
3. Name what is necessary to begin computer based information search.
4. When were network electronic systems first introduced?
5. What can you do through Internet?
6. How can you use home computer?
7. What do you need to get started in E-mail?
8. How should you use E-mail?

## VI. WHAT IS MATHEMATICS?

The students of mathematics may wonder where the word "mathematics" comes from. Mathematics is a Greek word, and, by origin or etymologically, it means "something that must be learnt of understood", perhaps "acquired knowledge" or "knowledge acquirable by learning" or "general knowledge". The word "mathematics" is a contraction of all these phrases. The celebrated Pythagorean school in ancient Greece had both regular and incidental members. The incidental members were called "auditors"; the regular members were named "**mathematicians**" as a general class and not because they specialized in mathematics; for them mathematics was a mental discipline of science learning. What is mathematics in the modern sense of the term, its implications and connotations? There is no neat, simple, general and unique answer to this question.

**Mathematics as a science**, viewed as a whole, is a collection of branches. The largest branch is that which builds on the ordinary whole numbers, fractions, and irrational numbers, or what, collectively, is called the **real number system**. Arithmetic, algebra, the study of functions, the calculus, differential equations, and various other subjects which follow the calculus in logical order are all developments of the real number system. This part of mathematics is termed the **mathematics of number**. A second branch is **geometry** consisting of several geometries. Mathematics contains many more divisions. Each branch has the same logical structure: it begins with certain **concepts**, such as the whole numbers or integers in the mathematics of number, and such as point, line and triangle in geometry. These concepts must verify explicitly stated axioms. Some of the axioms of the mathematics of number are the **associative**, **commutative**, and **distributive** **properties** and the axioms about **equalities**. Some of the axioms of geometry are that two points determine a line, all right angles are equal, etc. From the concepts and axioms **theorems are deduced**. Hence, from the standpoint of structure, **the concepts**, **axioms** **and theorems are the essential components** **of any compartment of mathematics**. We must break down mathematics into separately taught subjects, but this compartmentalization taken as a necessity, must be compensated for as much as possible. Students must see the interrelationships of the various areas and the importance of mathematics for other domains. Knowledge is not additive but an organic whole and mathematics is an inseparable part of that whole. The full significance of mathematics can be seen and taught only in terms of its intimate relationships to other fields of knowledge. If mathematics is isolated from other provinces, it loses importance.

**The basic concepts** of the main branches of mathematics are **abstractions from experience**, implied by their obvious physical counterparts. But it is noteworthy, that many more concepts are introduced which are, in essence, creations of the human mind with or without any help of experience. Irrational numbers, negative numbers and so forth are not wholly abstracted from the physical practice, for the man's mind must create the notion of entirely new types of numbers to which operations such as addition, multiplication, and the like can be applied. The notion of **a variable** that represents the quantitative values of some changing physical phenomena, such as temperature and time, is also at least one mental step beyond the mere observation of change. The concept of a function, or a relationship between variables, is almost totally a mental creation.

The more we study mathematics the more we see that the ideas and conceptions involved become more divorced and remote from experience, and the role played by the mind of the mathematician becomes larger and larger. The gradual introduction of new concepts which more and more depart from forms of experience finds its parallel in geometry and many of the specific geometrical terms are mental creations.

As mathematicians nowadays working in any given branch discover new concepts which are less and less drawn from experience and more and more from human mind the development of concepts is progressive and later concepts are built on earlier notions. These facts have unpleasant consequences. Because the more advanced ideas are purely mental creations rather than abstractions from physical experience and because they are defined in terms of prior concepts it is more difficult to understand them and illustrate their meanings even for specialist in some other province of mathematics. Nevertheless, the current introduction of new concepts in any field enables mathematics to grow rapidly. Indeed, the growth of modern mathematics is, in part, due to the introduction of new concepts and new systems of axioms.

**Axioms** constitute the second major component of any branch of mathematics. Up to the XIX century axioms were considered as basic self- evident truths about the concepts involved. We know now that this view ought to be given up. The objective of mathematical activity consists of the **theorems** deduced from a set of axioms. The amount of information that can be deduced from some sets of axioms is almost incredible. The axioms of number give rise to the results of algebra, properties of functions, the theorems of the calculus, the solutions of various types of differential equations. **Mathematical theorems must be deductively established and proved**. Much of the scientific knowledge its produced by deductive reasoning; new theorems are proved constantly, even in such old subjects as algebra and geometry and the current developments are as important as the older results.

Growth of mathematics is possible in still another way. Mathematicians are sure now that sets of axioms which have no bearing on the physical world should be explored. Accordingly, mathematicians nowadays investigate algebras and geometries with no immediate applications. There is, however, some disagreement among mathematicians as to the way they answer the question: Do the concepts, axioms, and theorems exist in some objective world and are merely detected by man or are they entirely human creations? In ancient times the axioms and theorems were regarded as necessary truths about the universe already incorporated in the design of the world. Hence each new theorem was a discovery, a disclosure of what already existed. The contrary view holds that mathematics, its concepts, and theorems are created by man. Man distinguishes objects in the physical world and invents numbers and number names to represent one aspect of experience. Axioms are man's generalizations of certain fundamental facts and theorems may very logically follow from the axioms. Mathematics, according to this view-point, is a human creation in every respect. Some mathematicians claim that pure mathematics is the most original creation of the human mind.

## VII.MATHEMATICS AND ART

*All science as it grows towards perfection and sophistication becomes mathematical in its ideas.*

*A.N.Whitehead*

Today mathematicians frequently liken mathematics and its creations to music and art rather than to science. It is convenient to keep the old classification of mathematics as one of the sciences, but it is more just to call it an art or a game. Unlike the sciences, but like the art of music or a game of chess, mathematics is foremost a free creation of the human mind. Mathematic is the sister, as well as the servant of the arts and is touched with the same genius. In the age when specialization means isolation, a layman may be surprised to hear that mathematics and art are intimately related. Yet, they are closely identified from ancient times. To begin with, the visual arts are spatial by definition. It is therefore not surprising that geometry is evident in classic architecture or that the ruler and compass are as familiar to the artist as the artisan. Artists search for ideal proportions and mathematical principles of composition. Many trends and traditions in this search are mixed.

Mathematics and art are mutually indebted in the area of perspective and symmetry which express relations only now fully explained by the mathematical theory of groups, a development of the last centuries. But does not art, in breaking away from academic canons nowadays, also break with mathematics? On the contrary. In the last one hundred years mathematics also has its liberation. From the science of number and space, mathematics becomes the science of all relations, of structure in the broadest sense. A mathematician, like a painter or a poet, is a marker of patterns. The mathematician’s patterns, like the painter’s or the poet’s must be beautiful; the ideas, like the colours or the words must fit together in a harmonious way. Beauty and elegance are the true test for both. The revolutions in art and mathematics only deepen the relations between them. It is a common observation that the emotional drive for creation and the satisfaction from success are the same whether one constructs an object of art or a mathematical theory.

In ancient Greece mathematics was transformed from a tool for the advancement of other activities to an art. Arithmetic, geometry and astronomy were to the classical Greece music for the soul and the art of the mind; indeed, rational and aesthetic can hardly be separated in Greek thought. Mathematic and art were fused harmoniously in a single individual during the Renaissance. Though the further developments tended to weaken the connection, it was reinforced again in the last century and recent revolutionary changes in both fields open new possibilities for interaction without weakening the potential role of each as inspiration to the other. In both areas the creative process involves observation and experiment, judgement and rejection, intuition and feeling, careful calculation and analysis, sophistication, flashes of insight, and possibly results that are thrilling, satisfying and useful to both the artist and his audience. Patterns in either field may illustrate, explain, or inspire work in the other. The new mathematics and the new art are capable of an intimacy that we have not seen since the Renaissance.

Since mathematics and the arts often deal with the same material in different idioms only the most careful study can show which precedes the other, but there is certainly much in modern art to inspire the mathematician, and there are many mathematical ideas whose artistic exploitation may reap a rich harvest. Perhaps modern art expresses intuitively many relations that appear deductively in mathematical theories. The professional mathematician has a strong poetic sense of form in his own language of mathematics and most mathematicians claim that there is great beauty in their science. Mathematics means problems, and problems demand solutions. When every mathematician is confronted with a problem he does his best to solve it by whatever means he can think of. But he also tries, if possible, to solve it in the most beautiful and simple manner which is the most fruitful in the long run. A mathematical problem or theory has a history, which follows the same pattern as in every science. But the fascination of mathematics has a flavor of its own. Mathematical problems not only appeal to the scientist’s delight in solving riddles but the definitely evoke aesthetic emotions. Contrary to the attitude of the experimental scientist, the result alone is not what matters to the mathematician, bat the difficulty coped with to obtain it. That is, what is beautiful in mathematics can never be merely skin-deep; it must penetrate deep into the bottom of the mathematical organism where all difficult problems converge.

In 1933 George Birkhoff, one of the most distinguished mathematicians of the generation, attempted to apply mathematics to art in the manner that proves so successful in other areas. He began with a presice formulation of the old idea that beauty depends on the relations of the parts of an art object. He defined aesthetic measure as varying inversely with the number of elements present and directly with the number of relations between them. Of course, the difficulty of the problem is to determine this two numbers in specific contents to discover the implications for design and to test and verify the conclusions against human aesthetic judgement. This Birkhoff attempted to do for painting, poetry and music. His work was an integration in the main stream of artistic and mathematical thought and showed great insight, ingenuity and sophistication.

During the many years from the age of Pythagoras to the nineteenth century, mathematicians and musicians alike sought to understand the nature of musical sounds and to find the relationship between mathematics and music. The climax to this long series of investigations, from a mathematical standpoint, came with the work of the mathematician Joseph Fourier, who showed that all sounds, vocal and instrumental, simple and complex, are completely describable in mathematical terms. Because of Fourier’s work not even the elusive beauty of a musical phrase escapes mathematical formulation. Whereas Pythagoras was content to pluck the strings of a lyre, Fourier sounded the whole orchestra. Stated as a theorem of pure mathematics Fourier’s formula *y =* sin *x* says about the relations among variables, which can be represented by means of a graph.

The graph shows that the function is regular or periodic; or we may say, the cycle of *y*-values repeats itself after every 360-unit interval of *x*-values. This function does not quite represent the sound of music but a very simple modification of it does. A little effort produces the proper modification and it can be summarized by the statement that the function *y = a* sin *bx,* where *a* and *b* are any positive numbers, has the amplitude *a* and the frequency *b* in 360 units of *x*-values. The formula represents sounds mathematically. But of course very few musical sounds are as simple as those that may be represented by the formula. What can the mathematician say about more complex musical sounds?

Part of the answer to the question is learned by observing the graphs of various sounds. The graphs of all musical sounds. The graphs of all musical sounds show regularity. In “graphic” terms we have, then, the distinguishing feature between pleasing and displeasing sounds, between musical sounds in the broad sense and noise. Unfortunately, such a great variety of musical sounds possesses this feature of regularity that further analysis and characterization is necessary – and yet this seemed impossible until the nineteenth century. Then Fourier entered the scene and dispelled the confusion.

What is the significance of Fourier’s theory? In mathematical language the theorem tells us that the formula for any musical sound is a sum of terms of the form *a* sin *bx*. Since each such term can represent a simple sound, the theorem says that each musical sound, however complex, is merely a combination of simple sounds. The mathematical deduction that any complex musical sound can actually be built up from simple sounds is physically verifiable. This resolution of complex sounds into partials or harmonics helps us describe mathematically the chief characteristics of all musical sounds. Thus, thanks to Fourier, the nature of musical sounds is now clear to us. But what can mathematics say about harmonic combinations of sounds, about the essence of beautiful musical compositions, about the “soul” of music? The role of mathematics in music stretches even to the composition itself. Masters such as Bach constructed and advocated vast mathematical theories for the composition of music. In such theories cold reason rather than feeling and emotions produce the creative pattern.

Of course the mathematical analysis of musical sounds is of great practical importance. The musical sounds of most instruments are considerably improved and perfected by the application of mathematics. The fact cannot be denied that mathematics not only aids in the design of musical instruments but sometimes mathematics rather than the ear is the arbiter of a perfect design. The engineering of practically all the components of complex instruments relies heavily on Fourier’s analysis of musical sounds. Even the layman can soon learn to speak Fourier’s language. In view of the many shares and bearings of mathematics to the production and reproduction of musical ideas the modern music lover evidently owes as much to Fourier as to Beethoven. There are philosophical overtones to Fourier’s work. The essence of beautiful music is obviously more than what mathematical analysis can show. Nevertheless, through Fourier’s theorem this major art leads itself perfectly to mathematical description. Hence, the most abstract of the arts can be transcribed into the most abstract of the sciences and the most reasoned of the arts is clearly recognized to be akin to the music of reason.

## VIII.Cybernetics

The word “cybernetics” originated from the Greek “kybernetike”, the Latin “gebernator” and the English “governor” all meaning, in one sense or another, “control”, “management” and supervision. More recently **Norbert Weiner** has used the word to name his book, which deals with the activity of a group of scientists engaged in the solution of a wartime problem and some of the mathematical concepts involved. Nowadays the word has become associated with the solutions of problems dealing with activities for computers. As such, the discipline must rely on the exact sciences as well as sciences such as biology, psychology, biochemistry and biophysics, neurophysiology and anatomy.

Before studying computer systems it is necessary to distinguish between computers and calculators. This terms have, by connotation, two distinctly different meanings. The term calculator will refer to a machine which (1) can perform arithmetic operations (2) which is mechanical (3) which has a key-board input (4) which has manually operated controls. (Examples: Adding machines, desk calculators). The term computer will refer to automatic digital computers which can (1) solve complete problems, (2) are generally electronic, (3) have various rapid input-output devices, (4) have internally stored control programmes (routines). Speed and general usefulness make a computer equivalent to thousands of calculators and their operators. The ability of electronic computers to solve mathematical and logical problems, thereby augmenting the efficiency and productivity of the human brain, has made the sphere of their application practically boundless.

It is difficult to say what the future holds in store for Cybernetics. Every day we learn more and more about the penetration of Cybernetics into the most widely differing spheres of human activity. The lauching of sputniks and the delivery of our space rockets to their orbits with such high accuracy could have been hardly possible without computers. This however, does not mean, that a machine can ever become “cleverer” than its creator. The point is that the machine does not replace man, it only increases his work output and multiplies his power over the forces of nature. It should be always remembered that the machine serves man, and not the other way round. Without man, even the most perfect machine would be only a useless heap of metal.

Man’s technical progress is reflected in the tools he has invented. From early times he has been ceaselessly creating and improving devices to assist his brain in completing tasks difficult or otherwise impossible. Throughout the centuries man has developed and refined the ability to record, process, and communicate information. With the advent of automatic digital computers, man has created devices that can solve complete problems without the need for human intervention during the course of solution. Although operations performed by computers are the very basic ones (addition, subtraction, multiplication, and division) great speed of operation is more than compensation. The principal use of computers has been in the area of applied mathematics. The application of computers to scientific problems has become later than the original business applications. Nowadays computers have become increasingly important as basic tools for analysis. This operation requires highly refined and flexible techniques.

The contributions of the scientists to the progress of Cybernetics consists of the evaluation, measurement and description of the capabilities and of structural and functional attributes of living organisms. Such studies involve the methods of communication, feedback and control in the living entity. Hence an important aspect of the work in Cybernetics for mathematicians deals with the mathematical theory of communication.

In terms of computer development Cybernetics is concentrated with the design and construction of electrical or electronic analogs capable of performing processes carried out within a living entity, including the selection and evaluation, as well as storage of information. In terms of understanding the operation of the human nervous system, Cybernetics contributes new insight into a wide range of processes such as learning, regulation and emotional behavior of individual human beings as well as societies. Specifically the problems of decision-making, thinking and synthesis, imagination and creative endeavour of people, come under the scrutiny of Cybernetics.

It is anticipated that the future developments of automated industries and societal functions will be based on the theorems developed from Cybernetics which thus far has made significant contribution to the technology of guided missiles, business and scientific computer applications, communications and automatic control. Cybernetics is a young science and yet it is increasingly applied in various branches of industry and research. Invading a wide range of fields in human activity. Cybernetics endeavours to find the answer to two major questions: the best way of controlling this or that process, and the best way of utilizing a machine (if possible) for controlling this process.

## IX.MATHEMATICS –­ THE LANGUAGE OF SCIENCE

What distinguishes the language of science from language as we ordinarily understand the word? How is it that scientific language is international? The supernational character of scientific concepts and scientific language is due to the fact that they are set up by the best brains of all countries and all times.

1. Einstein

One of the foremost reasons given for the study of mathematics is, to use a common phrase, that “mathematics is the language of science”. This is not meant to imply that mathematics is useful only to those who specialize in science. No, it implies that even a layman must know something about the foundations, the scope and the basic role played by mathematics in our scientific age.

The language of mathematics **consists** mostly of signs and symbols, and, in a **sense**, is an unspoken language. There can be no more universal or more simple language, it is the same throughout the civilized world, though the people of each country translate it into their own particular spoken language. For instance, the symbol 5 means the same name to a person in England, Spain, Italy or any other country; but in each country it may be called by a different spoken word. Some of the best known symbols of mathematics are the numerals 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 and the signs of **addition** (+), **subtraction** (.), **multiplication** (×), **division** (:), **equality** (=) and the letters of the alphabets: Greek, Latin, Gothic and Hebrew (rather rarely).

Symbolic language is one of the basic characteristics of modern mathematics for it determines its true aspect. With the aid of symbolism mathematicians can make transitions in **reasoning** almost mechanically by the eye and leave their **mind** free to grasp the fundamental ideas of the **subject matter**. Just as music uses symbolism for the **representation** and **communication** of sounds so mathematics expresses quantitative **relations** and spatial forms symbolically. Unlike the common language, which is the **product** of custom, as well as social and political movements, the language of mathematics is carefully, purposefully and often ingeniously **designed**. By virtue of its compactness, it permits a mathematician to work with ideas which when expressed in terms of common language are **unmanageable**. This compactness **makes for** efficiency of thought.

Mathematical language is precise and concise, so that it is often **confusing** to people unaccustomed to its forms. The symbolism used in mathematical language is essential to distinguish **meanings** often confused in common speech. Mathematical style aims at brevity and formal perfection. Let us suppose we wish to express in general terms the Pythagorean theorem, well-familiar to every student through his high-school studies. We may say: "We have a right triangle. If we construct two squares each having an arm of the triangle as a side and if we construct a square having the hypotenuse of the triangle for its side, then the area of the third square is **equal** to the sum of the areas of the first two". But no mathematician expresses himself that way. **He prefers**: "The sum of the squares on the sides of a right triangle **equals** the square on the hypotenuse". In symbols this may be stated as follows: *c2 = a2 + b2.* This economy of words makes for conciseness of presentation, and mathematical writing is remarkable because it encompasses much in few words. In the study of mathematics much time must be **devoted** 1) to the expressing of verbally stated facts in mathematical language, that is, in the signs and symbols of mathematics; 2) to the translating of mathematical expressions into common language. We use signs and symbols for convenience. In some cases the symbols are **abbreviations** of words, but often they have no such relation to the thing **they stand for**. We cannot say why they stand for what they do, they **mean** what they do by common agreement or by **definition**.

The student must always remember that the understanding of any **subject** in mathematics presupposes clear and definite knowledge of what precedes. This is the **reason** why "there is no royal road" to mathematics and why the study of mathematics is discouraging to weak **minds**, those who are not able and willing to master the subject.

## X. Hardware — software — firmware

A fundamental issue in the design of any computer is how control or steer the electrical signals that represent information. In the arithmetic and logic unit, where the actual processing of information is done, signals must be routed between various counters, adders and other components. The control system must also mediate the transfer of information between the central processor, the main memory units and the various input and output devices. In one approach the control system is completely "hard-wired", that is, it is laid down permanently in the processor's electrical circuitry. A second approach is more flexible and in many cases less expensive. The essential idea is to reduce the complexity of the control system by recording the detailed instructions for control¬ling the computer in a coded form. In other words, the sequence of paths is to follow is embodied in a programme, which is stored in a separate memory unit incorporated into the processor.

In the hierarchy of programmes that operate a computer the instructions executed by the control system occupy the lowest and most elementary level; each instruction specifies a single functional state of the machine. Because the control instructions are responsible for such fine details, the task of defining and encoding them is termed microprogramming, thereby distinguishing it from the writing of the higher-level programmers known generically as software. A set of control instructions – a microprogramme – is written in microcode. The idea of microprogramming was conceived more than 30 years ago soon after the advent of the first computers. At the time the hardware needed to implement the idea did not yet exist. The method has been adopted, however, in most computers that are being built today. Evolutionary successor of the minicomputer, the microcomputer, is a set of microelectronic “chips” serving the various computer functions. If has opened up new realms of computer applications. In recent years a good deal of confusion has arisen about the meaning of the term microprogramming, owing largely to the advent of the microprocessor (the computer on a chip) that is at the heart of the latest products of the progressive miniaturization of silicon-based semiconductor technology. It must be emphasized that microprogramming a computer is not the same as programming a microcomputer; in principle any computer, from the largest “mainframe” system to the smallest personal computer can be designed with a microprogrammed control system. To avoid such confusion microprogrammes are sometimes classified as “firmware”, thereby signifying their intermediate status between hardware and software. In most modern computers the routing of information is controlled at the lowest level by a microprogramme, i.e., a set of stored instructions that function in place of a completely “hard-wired” control system.

Computers can do the following tasks:

1. Computers free the researchers of lengthy and boring computations.

2. A computer perceives pure bookish knowledge and information more readily. A computer reads texts and summarizes them.

3. A computer reasons, converses, and even learn new words.

4. A computer translates from English into other languages and conversely.

5. A computer can do Geometric analogy intelligence tests.

6. A computer can do expert probem-solving and pattern recognition,

7. A computer can do useful industrial work.

8. A computer can model psychological processes.

9. A computer can understand drawings and make drawings itself.

10. A computer igeniously pursues scientific and engineering goals.

XX. Complete and extend the given sentences.

Model. Computers can never...

Computer s can never appreciate aesthetics. Computers can ne¬ver possess consciousness, intuition, common sense, insight, ingenuity.

1. Computers can never do ... 2. Software can never equal brain-ware because ... 3. Intelligence can never be understood as ... 4. Com¬puter can never model psychological processes precisely as ... 5. Com¬puters can never play a champion chess game at a speed comparable to human because 6. Computers cannot produce idiomatic language translation as ...

## XI. Can people converse with the computers on any topic they might pick and in their native languages?

It’s unlikely, for the time being. People cannot so far communicate with computers in a natural human way. Can the computer respond to man’s questions and say anything when it is told or asked? It will be able to, sure enough. The first generation of computers were operated by valves, then there were transistors. Next came the silicon chip and then an even better silicon chip. Now it is possible to look forward to the next generation of computers. These simply in terms of numbers. In a sense this new type of computer will copy the operation of the human brain, dealing with problems in parallel rather than simply one after the other. We will able to talk to it – but using a very limited vocabulary of technical terms. The next step may be computers at telephone exchanges, doing actual translation work. You want, perhaps, to ring up someone in Tokyo. You speak English – the machine translates for you and the other person hears a Japanese version of what you said. That will be a major step forward. But as for having a nice chat over a cup of coffee, that will have to wait till later.

Dutch booksellers who telephone the Netherlands’ central book warehouse hear the voice of a pleasant operator who answers questions about titles and prices and takes their order. The operator never misses a day of work – unless the overloads a circuit. “He” is a computer called Boektel, which owes its voice to a new speech-synthetic system. The Voice Response System (VRS) can be programmed to speak in any language in a clear, if slightly metallic, voice. Although it does not understand human speech, callers can give it instructions using a standard Touch-Tone telephone, making the system ideal for airlines, banks and other firms that must get answers or disseminate up-to-date information over the phone. First the VRS may say, “if you want to know about title availability, press 2”. The user then simply presses the phone key marked “2” to signal the VRS to continue. Up to 48 telephone lines can be connected to one VRS; the Boektel system, which has 32 lines, handles as many as 500 calls each day. 5,000 VRS units have already been installed around the world. A similar system has been recently developed that is a veritable computer mimic. It has the ability to sound like a middle-aged woman, an elderly man, a child or a deep-voiced man. The system is contained in a box about the size of a large typewriter.

## XII. Computer Memory

The organization of computer memory has received much attention over the years. There are two general ways of partitioning memory, which can be called vertical and horizontal. The incentive for structuring memory in a ver¬tical or hierarchical manner is that fast memories cost more per bit than slower ones. Moreover, the larger the memory is, the longer it takes to access items that have been stored randomly. The processing units in most large computers communicate directly with a small, very fast memory of perhaps several hundred words. Data can be transferred to or from one of these disk units at a maximum rate of half a million words per second, and in practice it is possible to maintain data flow between central memory and several disk units simultaneously.

The maximum rate of transfer of information to or from a memory device is known as a bandwidth. In order for the average computing speed not to be dominated by the smaller bandwidth of the lower memory levels, programs must be arranged so that as much computation as possible is done with instruction and data at the higher levels before the need arises to reload the higher level from the one below. This is an important consideration in programming vector operations for supercomputers, whose central-memory bandwidth is small in relation to the megaflop rate that can be sustained for data held in the register set.

Several multiprocessing supercomputers currently under development incorporate a number of independent parallel memory modules that linked to an equal number of independent processors through a high-speed program-controlled switch so that all the memories are equally accessible to all the processors. For pipelines processors still another kind of horizontal partitioning of central memory has been devised: the memory is divided into a number of "phased" memory banks, so described because they operate with their access cycles out of phase with one another. The rationale for the scheme is that random-access central memories are relatively slow, requiring the passage of a certain minimum number of clock periods between successive memory references. In order to keep vector operands streaming at a rate of one word per clock period to feed a pipeline, vectors are stored with consecutive operands in different banks. The phase shift that "opens" successively referenced banks is equal to one processor clock period. The supercomputers – the Cyber 205 has 16 phased banks; the Cray-1 has 8 or 16, depending on the memory size. In both supercomputers mentioned the bank cycle time is equal to four processor cycles.

The memory of the modern supercomputers – is organized hierarchically. The two register memories are the smallest, followed in capacity by central memory, extended semiconductor memory and disk memory. The extended semiconductor memory has just begun to appear in supercomputer installations because rotating-disc technology has not kept pace with the increasing speed of processors. The largest such memory, with the capacity of 8 million words is in the Cray-1 supercomputer. Here all the functional units are “pipelined”; meaning that tasks are broken into elements that can be executed at peak speed and reassembled in a continuous flow, thereby achieving one floating-point operation per clock period: 20 nanoseconds in the Cyber 205 and 12,5 nanoseconds in the Cray-1.

All the functional units can run concurrently, but not all can run at top speed concurrently because they share common resources, such as data paths 01 memory access cycles. Moreover, conditional branches in the program interrupt the smooth flow of instructions through the instruction processor. Before the processor issues an instruction, it must wait until it is clear that all the resources needed for the execution of the instruction will be available when they are needed. In the Cray-1 the register memories incorporate further hierarchical structure, and the vector processor holds additional register memory. The vector processors of the Cray-1 and Cyber-205 also differ significantly in other respects. The disc-based secondary storage systems of both the Cry-1 and the Cyber-205 are too slow to allow any feasible solution of continuous-field simultation whose iterative data base is too large to fit in the machines central memory.

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Reading and Comprehension

Составитель

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