Московский государственный технический университет
имени Н.Э. Баумана

Учебно-методическое пособие

О.Д. Дикова, Л.А. Иванова, Е.А. Юдачева

ОБУЧЕНИЕ ЧТЕНИЮ ЛИТЕРАТУРЫ НА АНГЛИЙСКОМ ЯЗЫКЕ ПО СПЕЦИАЛЬНОСТИ «ПРИКЛАДНАЯ МАТЕМАТИКА»

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Д 45 Обучение чтению литературы на английском языке по специальности «Прикладная математика»: Учеб.-метод. пособие. – М.: Изд-во МГТУ им. Н.Э. Баумана, 2007. – 35 с.

Пособие содержит тексты о сущности математики как науки и ее связях с другими науками, исследовательских методах, об истории обучения математике в Великобритании. Кроме того, даны лексический и терминологический материал, а также задания, позволяющие приобрести навыки понимания и перевода литературы по прикладной математике с английского языка на русский.

Для студентов старших курсов факультета «Фундаментальные науки».

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ПРЕДИСЛОВИЕ

В пособие включены оригинальные тексты из английской и американской литературы по специальности «Прикладная математика» для самостоятельной работы студентов старших курсов. Каждый из трех разделов включает также задания по развитию навыков перевода с английского языка на русский, ведения беседы по основным темам, затронутым в пособии, задания по переводу с русского языка на английский, по отработке лексического и грамматического материала, связанного с текстами. После первого текста в каждом из трех разделов помещен словарь основной лексики, включающий в том числе часто используемые словосочетания.

Владение терминологией по изучаемой специальности и языковыми оборотами позволит студентам и выпускникам получать необходимую информацию, знакомясь с научно-технической литературой на английском языке, участвовать в обсуждении профессиональных вопросов с иностранными коллегами.

UNIT 1

TASK 1. *Read and translate the text.*

Text 1 A. The Main Approaches to Solving Problems in Fluid Mechanics and Heat Transfer

There are basically three approaches or methods which can be used to solve a problem in fluid mechanics and heat transfer. These methods are:

1) experimental;
2) theoretical;
3) numerical.

The theoretical method is often referred to as an analytical approach while the terms numerical and computational are used interchangeably.

In the experimental approach, a model would first need to be designed and constructed. The model must have provisions for measuring necessary parameters and should be compatible with an existing experimental facilities. The measurements having been completed, correction factors can be applied to the raw data to produce the final results. The experimental approach has the capability of producing the most realistic answers for many problems; however the costs are becoming greater every day.

In the theoretical approach, simplifying assumptions are made in order to make the problem tractable. The big advantage of the theoretical approach is that "clean", general information can be obtained, in many cases, from a simple formula. This approach is quite useful in preliminary design work since reasonable answers can be obtained in a minimum amount of time.

In the numerical approach, a limited number of assumptions are made and a high speed digital computer is used to solve the resulting equations.

In comparing the methods we note that a computer simulation is free of some of the constraints imposed on the experimental method for obtaining information upon which to base a design. This represents a major advantage of the computational method which should be increasingly important in the future. The idea of experimental testing is to evaluate the performance of a relatively inexpensive small scale version of the prototype design. In performing such tests, it is not always possible to simulate the true operation conditions of the prototype. This suggests that the computational method, which has no such restrictions, has the potential of providing information not available by other means. On the other hand, computational methods also have limitations; among these are computer storage and speed. Other limitations arise due to our inability to understand and mathematically model certain complex phenomena. None of these limitations of the computational method are insurmountable in principle and current trends show reason for optimism about the role of the computational method in future.

2180

Essential Vocabulary*

provisions [prə´viʒ(ə)ns] – средства
compatible [kəm´pætəbl] – совместимый
simplifying assumption [´simplifaiiŋ ə´sʌmpʃ(ə)n] – упрощающее предположение
tractable [´træktəbl] – решаемый
constraint [kən´streint] – ограничение
performance [pə´fɔməns] – характеристики
prototype design [´prəutətaip di´zain] – опытный образец
restriction [ris´trikʃ(ə)n] – ограничение
computer storage – компьютерная память
computer speed – быстродействие компьютера
insurmountable [ˏinsə(:)´mauntəbl] – непреодолимый, неустранимый

TASK 2. *Consult a dictionary and suggest Russian equivalents for the following words and word combinations.*

A

to refer – reference – to be referred to; to apply – appliance – application – ´applicable – ´applicant – to be applied to.

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* Во всех разделах пособия слова, вошедшие в *Essential Vocabulary*, даны в том порядке, в котором они встречаются в основных текстах, отмеченных буквой *A*. Здесь и далее даны те значения слов, которые нужно знать, чтобы перевести эти тексты на русский язык.

B

in terms of, to be free of smth., on the other hand, current trends, to show reason.

TASK 3. *Answer the questions.*

1. What is the difference between theoretical and experimental approaches?
2. What is the main advantage of experimental approach?
3. In what case can we use it?
4. When is the theoretical approach most useful?
5. What is the necessary condition for the numerical method use?
6. What is the main idea of experimental testing?
7. The numerical methods are universal, aren't they? Why?
8. Is it possible to use computational methods in any case? Why?
9. What are the limitations of the numerical approach?
10. Will the numerical methods replace analytical and experimental ones in future? Why?

TASK 4. *Compare three methods which can be used to solve a problem.*

TASK 5. *Choose all passive constructions from the text and translate them using the following grammar material.*

Passive Constructions

	Simple	*Progressive*	*Perfect*
Present	It *is taken* They *are asked*	It *is being taken* They *are being asked*	It *has been taken* They *have been asked*
Past	It *was taken* They *were asked*	It *was being taken* They *were being asked*	It *had been taken* They *had been asked*
Future	It *will be taken* They *will be asked*	–	It will have been taken They *will have been asked*

to be continued

	Simple	*Progressive*	*Perfect*
Future-in-the-Past	It would be taken They would be asked	–	It would have been taken They would have been asked
Употреб-ление	Действия, обычные, повторяемые, регулярные	Действия, протекающие в данный момент	Действия, завершенные к определенному моменту

TASK 6. *Translate the sentence underlined in the text, and explain the use of Participle construction with the following grammar material. Try to memorize it.*

having + Participle II = having finished having been + Participle II = having been finished

	В переводе:	
Active: having + Participle II → обстоятельство	1) деепричастие совершенного вида	Having finished his experiments he compared the results. Закончив эксперименты, он сравнил результаты.
Passive: having been + Participle II → обстоятельство	2) придаточные обстоятельственные предложения с союзами *после того как*, *так как*	Having been translated into many languages, this book became known all over the world. После того как эта книга была переведена на многие языки, она стала известна во всем мире.

TASK 7*. Translate from Russian into English.*

История вычислительной гидромеханики тесно связана с развитием ЭВМ. До конца Второй мировой войны большинство задач решалось аналитическими и экспериментальными методами. До этого лишь отдельные пионеры применяли численные методы для решения задач. Расчеты выполнялись вручную, и каждое решение было результатом огромной работы и требовало очень много времени. С появлением ЭВМ рутинная работа, связанная с получением результатов при численном решении, проводится довольно просто.

Иногда начало современной вычислительной математики относят к 1928 г., когда стали обсуждаться вопросы существования и единственности решения уравнений в частных производных.

TASK 8*. Translate the text with a dictionary.*

Text 1 B. What is Mathematics?

Mathematics is a fusion of skillful operations with concepts and rules invented just for this purpose. The principal emphasis is on invention of concepts, which go beyond those contained in the axioms. Those are defined with a view of permitting ingenious logical operations which appeal to our aesthetic sense both as operations and also in their results of great generality and simplicity. Without concepts a mathematician would not go far. Those may or may not be suggested by the actual world. Mathematics is independent of material objects. In mathematics the word “exists” can have only one meaning: it signifies exemption from contradiction. In fact most of the advanced concepts in mathematics are those on which a mathematician can demonstrate his ingenuity and sense of beauty. Take for example “complex numbers”, the introduction of which cannot be suggested by physical observations. A mathematician’s interest in complex numbers lies in that many beautiful theorems in analytical functions owe their origin to the introduction of complex numbers. It so happened that much later complex numbers became essential in the formulation of quantum mechanics where they are not a calculational trick of applied mathematics. Indeed mathematics can not be defined without acknowledging its most obvious feature: namely, that it is interesting. It is appropriate to mention Cambridge Mathematician Godfrey Hardy and his book “A Mathematician's Apology", where he wrote: "A mathematician, like a painter or a poet is a maker of patterns. If his patterns are more permanent than theirs, it is because they are made in the ideas. The matematician's patterns like the painter's or poet's must be beautiful; the ideas, like the colours or the words, must fit together in a harmonious way. Beauty is the first test, there is no place in the world for ugly mathematics." The role which mathematics plays in physical sciences, where one is concerned to understand basic mysteries of nature, has also beauty of its own and a source of joy and excitement to its practitioners. Indeed "a scientist worthy of name, above all a mathematician, experiences in his work the same impression as an artist, his pleasure is as great and of the same nature".

2250

TASK 9. *Translate the text with a dictionary.*

Text 1 C. What is a Mathematical Problem Solution?

To solve a mathematical problem originally meant to find its complete numerical solution. Gradually it became clear that such explicit solutions are possible only in explicit cases, that in general one must be satisfied with a scheme by which the solution may be determined approximately, though with any desired accuracy. Something quite different is very frequently offered as the solution of a mathematical problem, namely a representation of the solution in terms of the data of a problem; although it is in principle possible to devise a scheme for numerical calculation from such a representation, the question remains: What actually is the solution? Mathematicians, in their search for representations of solutions, have often modified the meaning of "solution" even further; to solve a problem has become simply to prove the unique existence of a solution.

Clearly, if a mathematical problem is the correct expression of a physical one it has a unique solution, for the physical situation to be determined from given data does actually occur. Thus to know that certain mathematical problems have unique solutions might seem to have no significance in mathematical physics. It would perhaps have none if it were obvious that the physical problem is correctly expressed in mathematical terms. But frequently this is not obvious at all.

The statement that a unique solution exists may then serve as a partial verification of the correctness of the mathematical expression of the problem. If the solution is not unique the data given are not sufficient; if the solution doesn't exist, the data are incompatible and fewer should be given.

1440

TASK 10. *Translate the text with a dictionary.*

Text 1 D. Mathematics in British Universities in the Seventeenth Century

By the beginning of the 17th century English Universities had partially revised their opinion of Mathematics and started to increase the quality of Mathematics instruction available. Oxford and Cambridge had both managed to produce several Mathematicians of excellent quality, despite the lack of support and encouragement those wishing to study the subject received. This changed when the first Chair in Geometry was set up in Oxford in 1619, six years after the Mathematics Chair in Aberdin started being held by a regent who taught Arithmetic, Geometry and Classical Physics. Cambridge was much slower in recognition Mathematics as anything other than a subdivision of the three Philisiphies, and the Lucasian Chair in Mathematics was not established in 1662. Although this increase in education in Mathematics was noticeable, the continued separation of University Mathematics and the commercial and industrial needs of the general populace continued and so a new educational establishment was formed.

Grasham College, founded in the late 1650's, was intended to provide a much more practical and useful knowledge of the sciences. It was vastly successful in this aim, giving public lectures in both Latin and English on those topics drawn from Geometry, Astronomy and Mathematics which attracted large numbers of people. It was through Grasham's that Logarithms and Trigonometrical advances relating to Navigation were spread so quickly after their development. It was also Grasham College that was later called the Royal Society of London. Other Colleges and Universities proposed to help spread the knowledge of the Mathematical Sciences.

Schools and Colleges varied a great deal in curriculum and standards. Some of them were comparable to Oxford and Cambridge and students were allowed to graduate from Edinburgh University after only a single year's extra study. These institutions were not the only source of learning, private tutors also picked up on the need for practical mathematical education and rapidly advertised their skills in this area.

1840

TASK 11. *Translate the text with a dictionary.*

Text 1 E. Semantic Networks (I)

A computer or robot seems stupid when you have to tell it exactly what to do and how to do it. One aim of Artificial Intelligence (AI) is to let you just describe your problem and have the machine solve it with general reasoning techniques. Typically, a general purpose reasoning program operates on a formal description of the particular problem. Like a capable human being, the program may need to use background knowledge of the subject area along with general common sense knowledge about the world. Somehow this knowledge must be represented in the machine. Recently attention in AI has shifted away from reasoning programs to knowledge representation as the primary challenge. Instead of using natural languages (which are highly arbitrary and ambiguous), such knowledge is often represented using abstract conceptual structures called semantic networks.

Certain computing tasks vital to industry, the professions, and the military have reached a practical limit beyond which conventional computing (ordinary data processing and mathematical modeling) cannot go. These tasks require explicit, in-depth conceptual analysis, rather than just repetitive processing of the elements of a model. In an AI system, the concepts and principles of the subject domain are arranged in an ordered structure called a knowledge base. Transcending mere storage and retrieval of asserted facts, the computer uses this structure to infer other knowledge from that which has been stored directly. This depends on using the fundamental semantic structure of the concepts involved, as opposed to the syntactic (grammar) structure of any particular language.

Several quite different sentences in English (or other languages) can all have the same essential meaning and underlying semantic structure: a network of interrelated conceptual units. A network is also a convenient way to organize information in a computer or database.

1950

UNIT 2

TASK 1. *Read and translate the text.*

Text 2 A. Computational (Numerical) Methods

The development of the high-speed digital computer has had a great impact on the way in which principles from the sciences of fluid mechanics and heat transfer are applied to problems of design in modern engineering practice. Problems can now be solved at a very little cost in a few seconds of computer time which would have taken years to work out with the computational methods and computers available three-four decades ago. The ready availability of previously unimaginable computing power has stimulated many changes. These were first noticeable in industry and research laboratories where the need to solve complex problems was the most urgent. More recently, changes brought about by the computer have been occurring in university classrooms where students are being exposed to the fundamentals which must be mastered in order to make the best use of modern computational tools.

We have been witnessing the rise to importance of a new methodology for attacking the complex problems in fluid mechanics and heat transfer which has become known as computational fluid dynamics. In the computational (or numerical) approach the equations (usually in partial differential form) which govern a process of interest are solved numerically. Some of the ideas are very old. The evolution of numerical methods, especially finite-difference methods for solving ordinary and partial differential equations began at about the turn of the century. The automatic digital computer was invented by J.V. Atanasoff in the late 1930's and was used from nearly the beginning to solve problems in fluid dynamics. Still, these events did not revolutionize engineering practice. The explosion in computational activity did not begin until a third ingredient, general availability of high-speed digital computers, occurred in the 1960's.

Traditionally, both experimental and theoretical methods have been used to develop designs for equipment and vehicles involving fluid flow and heat transfer. With the advent of the digital computer, a third method, the numerical approach, has become available. Although experimentation continues to be important, especially when the flows involved are very complex, the trend is clearly toward greater reliance on computer based predictions in design.

The suggestion here is not that computational methods will soon completely replace experimental testing as a means to gather information for design purposes. Rather it is believed that computer methods are likely to be used more extensively in the future. The need for experiments will probably remain for some time in some applications where it is presently not economically feasible to utilize computational models which are free of empiricism. In most design situations it will still be necessary to employ some experimental testing. However computer studies can be used to reduce the range of conditions over which testing is required.

2850

Essential Vocabulary

fluid mechanics [´flu(:)id mi´kæniks] – гидромеханика
heat transfer [hi:t ´trænsfə(:)] – теплопередача
computational approach [ˏkɔmpju´teiʃənl ə´prəutʃ] – вычислительный подход (метод)
numerical approach [nju(:)´merik(ə)l ə´prəutʃ] – численный подход (метод)
partial differential equation [´pa:ʃ(ə)l ˏdifə´renʃ(ə)l i´kweiʃ(ə)n] – уравнение в частных производных
to govern [´gʌv(ə)n] – регулировать, управлять
to govern a process [´gʌv(ə)n ə ´prəusəs] – описывать процесс
finite-difference method [´fainait ´difr(ə)ns ´meθəd] – метод конечных разностей
advent [´ædvənt] – появление, прибытие, приход
empiricism [em´prisizm] – эмпиризм, эмпирический вывод, эмпирическая информация

TASK 2. *Consult a dictionary and suggest Russian equivalents for the following words and word combinations.*

A

to expose – to be exposed to; to work out – to work out a problem; to involve – equipment involving fluid flow – the flows involved;

to solve – to solve a problem – solvability – solvable – solvency – solvent; avail – available [ə΄veiləbl] – ready availability [ə¸veilə΄biliti] – of no avail – to avail [ə΄veil]; reliance [ri΄laiəns] on smth. – to rely [ri΄lai] on smth.; in order to – on the order of .

B

to master smth., to have a great impact on smth., to take smb. some time to do smth., to witness smth., at the turn of the century, the explosion in activity, economically feasible, decade [΄dekeid], range of conditions.

TASK 3. *Answer the questions.*

1. What has had a great impact on the way of problem solving in modern engineering practice?
2. Why did the development of computer technology stimulate changes in science and industry?
3. Where did the changes brought about by the computer occur first?
4. When was the automatic digital computer invented? Who was the inventor?
5. When did the finite-difference methods begin being widely used?
6. Was the computer widely used at that time? Why?
7. When did the high-speed digital computer appear?
8. What approaches are used for designing equipment involving fluid flow and heat transfer?
9. Why can't computational methods completely replace experimental testing?
10. What is the author's conclusion on the point?

TASK 4. *Give a gist of the text.*

TASK 5*. Translate the sentence underlined in the text and explain the grammar construction using th following table.*

Complex Subject + Infinitive Constructions

to say	is said + inf., was said + inf.	говорят, говорили
to know	is known+ inf., was known + inf.	известно, было известно
to report	is reported+ inf., was reported+ inf.	сообщают, сообщили
to suppose	is supposed + inf., was supposed + inf.	предполагают, предполагали
to expect	is expected + inf., was expected + inf.	ожидают, ожидали
to consider	is considered + inf., was considered + inf.	считают, считали
to believe	is believed + inf., was believed + inf.	полагают, полагали
to assume	is assumed + inf., was assumed + inf.	
to think	is thought + inf., was thought + inf.,	думают, думали
to seem	seems + inf., seemed + inf.	кажется, казалось
to appear	appears + inf., appeared + inf.	оказывается, оказалось
to prove	proves + inf., proved + inf.	
to happen	happens + inf., happened + inf.	
to be likely	is likely + inf., was likely + inf.	вероятно, было вероятно
to be unlikely	is unlikely + inf., was unlikely+ inf.	невероятно, было невероятно
to be sure	is sure + inf., was sure + inf.	безусловно, было безусловно
to be certain	is certain + inf., was certain+ inf.	несомненно, было несомненно

TASK 6. *Mind the pronunciation of the nouns from Latin and Greek in singular and plural forms. Learn them by heart.*

Singular	Plural
alumna [ə´lAmn əs] – выпускник	alumni [ə´lAmnai] – выпускники
antenna [æn´tenə] – антенна	antennae [æn´teni:] – антенны
axis [´æksis] – ось	axes[´æksi:z] – оси
basis [´beisis] – базис, основа	bases[´beisi:z] – базисы, основы

to be continued

Singular	Plural
calculus [΄kælkjuləs] – исчисление	calculi [΄kælkjulai] – исчисления
curriculum [kə΄rikjuləm] – учебный план	curricula [kə΄rikjulə] – учебные планы
crisis [΄kraisis] – кризис	crises [΄kraisi:z] – кризисы
datum [΄deitəm] – данная величина	data [΄deitə] – данные
formula [΄f0:mjulə] – формула	formulae [΄f0:mjuli:] – формулы
hypotesis [hai΄p0θisis] – гипотеза	hypoteses [hai΄p0θi si:z] – гипотезы
index [΄indeks] – указатель	indices [΄inde si:z] – указатели
matrix [΄meitriks] – матрица	matrices [΄meitrisi:z] – матрицы
medium [΄mi:djəm] – среда	media [΄mi:djə] – среды
nucleus [΄nju:klis] – ядро	nuclei [΄nju:kliai] – ядра
phenomenon [fi΄n0minən] – явление	phenomena [fi΄n0minə] – явления
radius [΄reidjəs] – радиус	radii [΄reidjai] – радиусы

TASK 7. *Translate from Russian into English.*

Для описания физического мира мы обычно применяем евклидову геометрию и считаем ее истинной. Другие геометрии, в основе которых лежит система аксиом, отличная от системы аксиом Евклида, иногда называют «воображаемыми геометриями». Примером может служить геометрия Римана и Лобачевского. Развитие физики и математики в XIX веке привело к тому, что для описания физического мира стали применяться другие геометрии и вопрос об истинности той или иной геометрии превратился в сложную философскую проблему. Образом прямой линии в геометрии Евклида мы считаем световой луч, но в действительности в гравитационном поле световые лучи искривляются и больше соответствуют образу евклидовой окружности, чем прямой линии. Вопрос об истинности фактически заменяется вопросом об удобстве описания физических явлений.

TASK 8. *Translate the text with a dictionary.*

Text 2 B. Applied Mathematics

The application of mathematics to industrial problems involves:

1) the formulation of problems which are amendable to mathematical investigation;

2) mathematical modelling;
3) the solution of the mathematical problem;
4) the interpretation of the results.

These steps are not clearly separated; the solution of the mathematical problem may lead to a refinement in the mathematical model or a change in the nature of the questions to be tackled by mathematical methods.

The problem will often initially be a vague question. What should the thickness of a magnetic screen be in order to reduce the magnetic flux density to the acceptable amount? What is the best strategy for using turbines and sluices in the proposed Severn barrage in order to maximize the energy output? How should the process of cooling fish be controlled in order to ensure thorough freezing? Such problems are usually posed by a team of engineers and scientists, often with the aid of a mathematician.

When a precise physical formulation of the problem has been obtained it must be approximated by a mathematical model. Often there will be several competing models of varying degrees of sophistication. Physical intuition and experience are invaluable to the modeling phase. The ideal is to study the simplest model which accurately describes the aspects of the problem in which one is interested. Occasionally numerical methods are unnecessary and analytical techniques will provide adequate understanding. However, the increasing power of ready available computers coupled with the development of high quality numerical algorithms and software allows the study of increasingly more sophisticated and complex mathematical models.

1700

TASK 9. *Translate the text with a dictionary.*

Text 2 C. The Laws of Nature Are Written in the Language of Mathematics (I)

First there is a mundane role which is to facilitate for the physicists the numerical calculation of certain constants or the integration of certain differential equations. Mathematics, does however, play a more sovereign role in which we will be concerned and bring out how higher mathematics found applications in subtle empirical problems.

“All laws are deduced from experiment, but to enunciate them, a special language is needed, ordinary language is too poor, it is besides too vague, to express relations so delicate, so rich and so precise”. This is attributed to Galilleo, more than 300 years ago.

Let us discuss an example.

The basic axioms of Newtonian mathematical physics is stated in the preface of the first edition of the Principia: rational mechanics ought to address “motion” with the same precision as geometry handles the size and shape of idealized objects. The association of “motion” (particularly the change in motion) with “mathematics” was a stroke of genius. The mathematical language in which it is formulated contained the concept of second derivative – not a very immediate concept. The act of writing down a fundamental law is a rather singular and rare event. It is a miracle that in spite of the baffling complexity in the world, certain regularities in the events could be discovered. A monumental example of such a law is Newton’s law of gravitation – a single law which explained everything from planetary motion to the terrestrial motion of pendulums and which appears simple to the mathematicians and which proved accurate beyond all reasonable expectations but still it is a law of limited scope.

1730

TASK 10. *Translate the text with a dictionary.*

Text 2 D. The Teaching of Mathematics in Britain in the Eighteenth Century

The effect of the Reformation in England carried on into the 18th century with both schools and Universities being too closely associated with the Church and State, partly due to the Act of Uniformity. Since neither encouraged progressive thought and innovation this resulted in a period of stagnation and decline. When Leeds Grammar School tried to change their curriculum from the traditional subjects of the Trivium to include French and Mathematics it resulted in Lord Eldon’s judgment which was very conservative (despite his own broad education), and prohibited future changes in Grammar School syllabuses. This did not change until Acts of 1812 and 1840 the first of which gave schools the possibility of limited changes to their curriculum but they had to apply to make any permanent changes, and the second which gave schools full power over what they taught.

With this restriction to the traditional syllabus many English Grammar schools forged associations with local private and dissident establishments, such as that formed between the Newcastle Grammar school and Charles Hutton's school in the same city. This meant that the Grammar students could take classes at Hutton's school in increasingly popular subjects such as Mathematics and French. This could only happen in the larger towns and cities which were well supplied with institutions supported either by philanthropists or groups of merchants wishing to provide a more practical education for their children. Mathematics and book-keeping courses were becoming more and more in demand as people began to realize that their job prospects increased with their knowledge and skills in these areas.

To provide the adult market with an equal opportunity to improve their computational skills, some of the better educated teachers and headmasters ran night classes and private lecture courses for groups of paying individuals. Many teachers went to night classes themselves in order to increase the number of topics that they could advertise for tutelage. Teaching such subjects was becoming more common because of an Act passed in 1713 (called the Act to Prevent Growth of Schism) which excluded teachers of Mathematics, Navigation and Mechanical art from swearing the oath included in the Act of Uniformity.

Other methods of improving your knowledge included attending public lectures given by the newly formed and rapidly increasing Mathematics Society, set up in 1717, which was predominantly aimed at the artisan and middle classes. These lectures were often very popular and the attendance could reach over three hundred. Lectures and private tutelage were more popular than they had been because of advances in teaching methods which made the courses more interesting.

Improvements in Mathematical education in Scotland moved along different lines. Many of the Scottish Councils were impressed with Christ's Hospital, Grasham College, and the Dissenting schools recently set up in England. Perth Council in particular ordered an enquiry into the academies and colleges appearing in England. This resulted in the Rev*. James Bonar advocating a two-session program leading to

* Reverend – преподобный.

a “modern” university course, and proposing that Perth was a suitable place for such higher education. The new academy, founded between 1760 and 1766, was the first Scottish school to teach science on a comprehensive scale. Sixteen other academies were set up (and survived) over the next seventy years in Dundee, Banff, Inverness and in other areas. Many of these were designed specifically to be mathematically and scientifically strong to compete with Grammar Schools like that in Ayr. Curriculum revision and improvement was soon forced by these new Academies and the Grammar schools (unrestricted by Lord Eldon's ruling) improved their Mathematics teaching abilities and the Academies soon introduced Latin to their already impressive range of courses. Perth Academy alone originally offered Higher Arithmetic, Mathematics, Geography, Logic, Algebra, Differential Calculus, Trigonometry, Navigation, Physics, Optics and many other subjects.

The strength of these new academies also pushed smaller schools and enterprises into copying them, introducing courses on the commercial applications of Mathematics. These smaller establishments were often sponsored by groups of philanthropists or similarly like minded individuals. Many other schools, or hospitals as they were then called, were set up using the money of successful merchants, most especially in Edinburgh and Glasgow. George Heriot's was the first, founded in the mid 17th century, and was intended to provide an education for the poor youths of Edinburgh. Two others followed in the same century, but the rate increased during the 18th century. The curriculum originally offered by these hospitals was limited, but rapidly grew through the demands of industry and the need to compete with the Academies.

4719

TASK 10. *Translate the text with a dictionary.*

Text 2 E. Semantic Networks (II)

A semantic network or net represents knowledge as a net-like graph. Throughout the text, “graph” means an interconnected vertex-and arc (dot-and-line) structure as studied in Graph Theory rather than a graph plotted in Cartesian X-Y coordinates. An idea, event, situation or object almost always has a composite structure; this is represented in a semantic network by a corresponding structure of nodes (drawn as circles or boxes) representing conceptual units, and directed links (drawn as arrows between the nodes) representing the relations between the units.

An abstract (graph-theoretic) network can be diagrammed, defined mathematically, programmed in a computer, or hard-wired electronically. It becomes semantic when you assign a meaning to each node and link. Unlike specialized networks and diagrams, semantic networks aim to represent a kind of knowledge which can be described in natural language. A semantic network system includes not only the explicitly stored net structure but also methods for automatically deriving from that a much larger structure or body of implied knowledge.

Let's consider a relational graph describing two individuals (tiger-cub Toby and the unnamed tigress) with their asserted qualities and relations, on top of which is an abstraction hierarchy of more general concepts and relations. From this combined structure it is possible to deduce things about the composite concept as a whole and its relations to other concepts. For example, the assertion that Toby is hungry implies that he is a conscious animal, and everything true of conscious animals is automatically true of Toby. Almost all systems have structured concept-hierarchies used for this kind of derivation, and these hierarchies themselves are also semantic networks.

1770

Unit 3

TASK 1. *Read and translate the text.*

Text 3 A. Physical and Mathematical Classification of Partial Differential Equations

Many important physical processes in nature are governed by partial differential equations (PDE's). For this reason it is important to understand the physical behavior of the model represented by the PDE. In addition, knowledge of the mathematical character, properties and solution of the governing equations is required. Here we will discuss the physical significance and the mathematical behaviour of the most common types of the PDE's encountered in fluid mechanics and heat transfer.

Physical classification

Equilibrium problems

Equilibrium problems are problems in which a solution of a given partial differential equation is desired in a closed domain subject to a prescribed set of boundary conditions. Equilibrium problems are boundary value problems. Examples of such problems include steady-state temperature distributions, incompressible inviscid flows, and equilibrium stress distributions in solids.

Sometimes equilibrium problems are referred to as jury problems. This is an apt name since the solution of the partial differential equation at every point in the domain depends upon the prescribed boundary condition at every point on the boundary. In this sense the boundary conditions are certainly the jury for the solution in the domain. Mathematically, equilibrium problems are governed by elliptic PDE's.

Marching problems

Marching or propagation problems are transient or transient-like problems where the solution of a partial differential equation is required on an open domain subject to a set of initial conditions and a set of boundary conditions. Problems in this category are initial value or initial boundary value problems. The solution must be computed by marching outward from the initial data surface while satisfying the boundary conditions. Mathematically these problems are governed by either hyperbolic or parabolic partial differential equations.

Mathematical classification

A general second-order partial differential equation is the standard model used to present the mathematical classification of partial differential equations. There are three types of partial differential equations. These are the elliptic, parabolic, and hyperbolic types. This terminology used in classifying PDE's is by analogy with the general second-order equations in analytic geometry. The wave equation, the heat equation, and Laplace's equation are examples of these types of equations.

In the classification of partial differential equations, many well-known names are associated with the specific problem types. The most well-known problem in the hyperbolic class is the Cauchy problem. This problem requires that one obtains a solution u to a hyperbolic PDE with initial data specified along a curve C. A very important theorem in mathematics assures us that a solution to the Cauchy problem exists. This is the Cauchy-Kowalevsky theorem. This theorem asserts that if the initial data are analytic in the neighborhood of x_0, y_0 and the function u_{xy} is analytic there, a unique analytic solution for u exists in the neighborhood of x_0, y_0.

Some discussion is warranted regarding the type of problem specification which is allowed for hyperbolic equations. For the second-order wave equation, initial conditions are required on the unknown function and its first derivatives along some curve C. It is important to observe that the curve C must not coincide with a characteristic of the differential equation. If an attempt is made to solve an initial value problem with characteristic initial data, a unique solution cannot be obtained. The problem is said to be "ill-posed".

In order for a problem involving a partial differential equation to be well-posed, the solution to the problem must exist and be unique, and the solution must depend continuously upon the initial or boundary data.

3800

Essential Vocabulary

governing equation – уравнение, описывающее (процесс)

equations encountered in fluid mechanics – уравнения, встречающиеся в механике жидкостей

equilibrium problems [ˏi:kwiˊlibriəm ˊprɔbləms] – задачи равновесия

closed domain [kləuzd dəuˊmein] – замкнутая область

boundary value [ˊbaund(ə)ri ˊvælju:] – граничное значение

steady-state temperature distribution [ˊstedi steit ˊtempritʃə ˏdistriˊbju:ʃ(ə)n] – установившееся температурное равновесие

inviscid [ˏinˊvisid] – невязкий, идеально текучий

inviscid flow [fləu] – поток без учета вязкости

equilibrium stress distributions – распределение равновесных напряжений apt name [æpt neim] – подходящее название

marching [´ma:tʃiŋ] problem – маршевая задача

propagation [ˏprɔpə´geiʃ(ə)n] problem – задача распространения

transient [´trænziənt] problem – нестационарная задача

initial [i´niʃ(ə)l] condition – начальное условие

jury [´ʤuəri] problem – задача суждения

elliptic [i´liptik] – эллиптический

hyperbolic [ˏhaipə(:)´bɔlik] – гиперболический

parabolic [ˏpærə´bɔlik] – параболический

assure [ə´ʃuə] – уверять, убеждать, гарантировать,

assert [ə´sə:t] – утверждать, доказывать

warrant [´wɔr(ə)nt] – оправдывать, гарантировать

derivative [di´rivətiv] – производная

ill-posed [il pəuzd] problem – некорректно поставленная задача

well-posed [wel pəuzd] problem – корректно поставленная задача

TASK 2. *Consult a dictionary and suggest Russian equivalents for the following words and word combinations:*

subject – to traverse a subject – to wander from the subject – subject matter – subject for smth. – delicate subject – on the subject of – subject to – to subject – subjection – subjective – subjective case – subjectivism – subjectivity; outward – outward things – outwardness – outwardly – toward – towards – northward.

TASK 3. *Answer the questions.*

1. How can we classify the physical behaviour of the model represented by the PDE's?
2. What is equlibrium problem?
3. Why are equilibrium problems sometimes refferred to as jury problems?
4. Which problems are governed by elliptic PDE's?
5. What are the types of partial differential equations? Which physical phenomena do they represent?
6. What does Cauchy-Kowalevsky theorem assert?

7. When can a unique solution of an initial value problem be obtained?

8. When is the problem said to be “ill-posed”?

TASK 4. *Speak on:*

a) physical classification of partial differential equations;
b) mathematical classification of partial differential equations.

TASK 5. *Translate the sentence underlined in the text, and explain the Grammar construction using the follonwing table.*

Modal Verbs and their Equivalents

Present	Past	Future
Can To be able to Мочь – обладать физической или умственной способностью	Could Was, were able to	Will be able to
May To be allowed to To be permitted to Мочь – иметь разрешение или возможность	Might Was, were allowed to Was, were permitted to	– will be allowed to will be permitted to
Must To be to To have to Быть должным, обязанным, вынужденным	– was, were to had to	– will be to will have to
Ought to следовало бы, следует, должен,	–	Ought to
Should Хорошо бы, следует, обязан	–	–

to be continued

Present	Past	Future
Would Присущее свойство, характеристика	Would = used to Обычное и повторяющееся действие Wouldn't Упорное нежелание выполнить действие	–
Needn't Не нужно, не следует	–	–

TASK 6. *Find all "ing-ending" forms in the text, explain them and translate all the words given in the following table.*

"Ing-ending" Forms

Noun	a morning	a building	a meaning
Adjective	interesting	following	misleading
Participle I	expressing	thinking	discussing
Gerund	in solving.	by measuring	without finding
Verbal Noun	the measuring of smth	the understanding of smth.	–
Preposition	concerning	regarding	owing to
Conjunction	providing	supposing	seeing
Adverb	according	notwithstanding	running

TASK 7. *Translate from Russian into English.*

Математик Х. Гольбах выдвинул гипотезу, что любое четное число можно представить в виде суммы двух простых чисел. Эта гипотеза до сих пор остается недоказанной. Проверено, что она справедлива для четных чисел вплоть до 100 000 000. Используя электронные вычислительные машины, можно даже собрать статистические данные, показывающие, сколькими различными способами то или иное четное число $2x$ разбивается на сумму двух простых. Оказывается, число способов довольно быстро растет с увеличением x. Академик И.М. Виноградов доказал, что любое достаточно большое нечетное число можно представить в виде суммы трех простых чисел.

Не существует формулы, позволяющей записать сколь угодно большое простое число. Известна, например, формула Эйлера $y = x^2 + x + 41$, которая для x = 0, 1, 2, …, 39 дает для y простое число. Однако остается неизвестным, имеется ли бесконечно много чисел, для которых многочлен Эйлера дает простое число. Существуют простые числа – “близнецы”, отличающиеся друг от друга на 2, например 11 и 13, 29 и 31. Но пока остается неизвестным, конечно или бесконечно число таких “близнецов”.

TASK 8. *Translate the text with a dictionary.*

Text 3 B. Applications of Mathematics

Mathematicians have always been fascinated by numbers. One of the most famous problems is Fermat’s Last Theorem that, if $n \geq 3$, the equation $x^n + y^n = z^n$ has no solutions with x, y, z all nonzero integers. An older problem is to show that one cannot construct a line of length $\sqrt[3]{2}$ with ruler and compass, starting with just a unit length.

Often the solution to a problem will lie outside the confines within which the problem has been posed, and theories must be constructed in order to prove a claim.

These are questions in pure mathematics. In applied mathematics we use mathematical concepts to explain phenomena that occur in the real world.

For example, lifting gear is required to meet certain standards. In particular chain links must comply to precise specifications. Essentially the problem is one of multivariate approximation with the requirement that the design formula be as simple and straightforward as possible.

During the last twenty years there has been considerable interest in developing alternative energy sources. Scientists consider problems arising from tidal power generation by means of a barrage across the river Severn and develop techniques for determining the maximal average energy output using optimal control theory. The first model provides a simple test example in which power is extracted from an oscillating system while the second model simulates tidal power generation from flow across a tidal barrage which contains both turbines and sluices. Numerical methods for computing solutions are derived and the predicted optimal strategies appeared to be often in contradiction to intuition.

Mathematical and numerical analysis can be used in forest management and environmental modeling. It is of interest to discover the orientation of leaves of trees in a forest. A mathematical model of this problem leads to the study of ill-posed linear Fredholm integral equation.

The nuclear industry has a particular interest in the ageing of steel. Stainless steel contains 15 – 20 % of chrome and 0,1 % of carbon and it is known that, at operating temperatures, the chrome and the carbon precipitate out with the effect that the steel is less able to withstand corrosive attack. A mathematical model consists of two, nonlinearly coupled, parabolic equations with very different time constants. There were computational difficulties associated with the direct solution of the parabolic equations because of the inherent stiffness of the problem.

If it is of interest for you, you can learn how a leopard gets its spots, examine the intricacies of quantum theory and relativity, or study the mathematics of financial derivatives.

2670

TASK 9. *Translate the text with a dictionary.*

Text 3 C. The Laws of Nuature are Written in the Language of Mathematics (II)

The concepts of modern physics are abstract. “Mathematics is the tool specially suited for dealing with abstract concepts of any kind and there is no limit in its power in this field” (P. Dirack). In this context let us consider two of the great theories of the XIX century: Relativity and Quantum Mechanics, both of which involve mathematics of transformations. This is because the important quantities in nature appear as the invariant or having simple transformation properties under these transformations. Let us consider them one by one:

i) General Theory of Relativity.

Einstein gave a new concept of gravity. Gravity cannot be switched off at will. Einstein argued that because of its permanency, gravity must be related to some intrinsic feature of space-time. He identified this feature as the geometry of space-time – only that this geometry is unusual. Existence of matter causes the fabric of space-time to wrap somewhat like the effect of a bowling ball placed on a foam. Such distortion to the fabric of space-time transmits the force of gravity from one place to another. Gravity resides in the curvature of space-time. The geometry which describes curved spaces is known as Reimann geometry.

ii) Quantum Mechanics.

There are two basic concepts in quantum mechanics: States and Observables. The states, which have no classical analogue, are vectors in Hilbert space. The observables are dynamical variables, which although appear in classical mechanics, are treated in quantum mechanics as hermitian operators on state vectors. Let us also remind ourselves that Hilbert space of quantum mechanics is complex with hermitian scalar product and as such the use of complex numbers is necessary in the formulation of laws of quantum mechanics.

In many cases mathematical concepts were independently developed by the physicist and recognized then as having been conceived before by the mathematician. Quantum mechanics is a good example of this where Dirack invented his own mathematics in his formulation of quantum mechanics. Einstein, on the other hand, recognized Remiann Geometry as tailor-made for implementing his view of gravitation force.

2220

TASK 9. *Translate the text with a dictionary.*

Text 3 D. The Teaching of Mathematics in Britain in the Nineteenth Century

This century saw the waning of the Church's power over schooling and education in Scotland. It was now generally accepted that some level of understanding of Mathematics was absolutely necessary for modern life, and there were few schools who did not give Mathematics a place in a student's timetable of classes.

Mathematics was also becoming easier, thanks to efforts made abroad to formulate Arithmetic into a series of easily understandable rules and operations. There was also a lot of work done on when and how a pupil should be taught. Pestalozzi's work of 1803 influenced many who then incorporated his reforms into their own schools.

The most fundamental of these were that children should start learning Mathematics and basic Arithmetic as soon as they entered school and that this work should be based on perception and the properties of physical objects. He also promoted a knowledge of the names of numbers and the simplest of Arithmetic operations before the introduction of figures and notation. What is perhaps most important is the position of prominence that Mathematics was placed in his school, no other subject was deemed more important at this stage of a pupil's education.

Such advances took time to filter into the more traditional education establishments. Much of Britain's institutions were still very conservative. Not the least of which were the two English Universities. The first half of the 19th century saw a revival of Mathematics education at Cambridge due in part to the efforts of Peacock, Babbage, and John Herschel who had formed the Analytical Society at Cambridge during their undergraduate years. By 1823 the analytical methods and notation of differential calculus made their way into the course. However, it is obvious that even then the examinations at Cambridge were still very narrow, and students who read more widely than the strict syllabus did not get recognized for their ability.

A short while later in 1826 a new institution advertising itself as being free from religious prejudice was founded. The University of London aimed to provide an education in Mathematics and Physical Science, Classics and Medicine. De Morgan got the chair of Mathematics at the newly opened university and it is through his efforts that methods for lecturing in Mathematics (and other subjects) improved in leaps and bounds. At the end of his lectures, De Morgan handed out sheets of problems based on that day's lecture. He then expected the students to attempt these problems and to hand in their solutions later so that he might mark them before handing them back with corrections. Hopefully they would learn from their mistakes, and he would find out where students were having difficulty understanding the ideas that he presented, and thereby improve his course for the following year.

De Morgan called for the methods of teaching whereby the pupil learnt the vocabulary of the subject, with many illustrations of the diagrams and constructions that they would later work with when studying the axioms and theorems. Teacher training schools were proposed in 1839, and started up in an attempt to improve this state of affairs, but the reaction against this project was so great that it was rapidly dropped. Some schools were up and running already, but privately and these were rare. Examination and certification of teachers was not put into general practice.

In the 1820's a new type of school started appearing. These included the Liverpool Institute, the London University, later renamed the London College School, and the Kings College School. These schools were less expensive due to being funded by a committee and, because they had been aimed at providing education for the middle classes, they sought more utilitarian ends. Because of its importance in the world of trade, commerce and industry, Mathematics and other sciences were given a pride of place in the syllabus.

In 1859 a Public Commission was established to inquire into the state of popular education in England and report what measures, if any, are required for the extension of sound and cheap elementary instruction to all classes of people. After that the changes and improvements to education, and the place that Mathematics held in the common curriculum, became much more rapid with several Government backed experiments leading the way to better methods and syllabuses.

4310

TASK 11. *Translate the text with a dictionary.*

Text 3 E. Correlated Measurement Errors

Industrial process control is an area in which correlated measurement errors are of interest. The tendency of some measuring instruments to "drift" or "wander" over time in a serially correlated, nondeterministic pattern was observed . If such measurement errors arise in a single-variable process control system, one may describe the resulting observations with univariate signal-plus-noise models. Consideration of several product or process characteristics, however, may lead to forms of inferential process control or Kalman filtering related to the multiple regression model

$$Y_i = x_t \beta + q_t, \tag{1}$$

where y_t is an r-dimensional row vector of dependent variables, x_t is a k-dimensional row vector of independent variables, β is a fixed $k \times r$

matrix of regression coefficients, and q_t is an r-dimensional, mean zero "error in equation" row vector associated with the derivation of the term y_t from the linear function $x_i\beta$. When neither y_t nor x_t is observed directly one may record p-dimensional observations $Z_t = (Y_t, X_t)$,
$t = 1, 2, \ldots, T$, where $p = r + k$,

$$Z_t = y_t + w_t, \; X_t = x_t + u_t. \qquad (2)$$

"Inferential process control" was described as an attempt to control a vector x_t of characteristics that are difficult or impossible to measure precisely during production, e. g., chemical composition of a product. Control actions are therefore determined by a vector Y_t of observations on "secondary characteristics" like temperature. Given a locally linear relationship between Y_t and x_t described by model (1) – (2), linear least square prediction of x_t is a relatively simple exercise, provided one knows the coefficient matrix B and the parameters of the x_t, qt, and wt processes. Given a set of imperfect observations X_t on the variables x_t, parameter estimation for inferential process control is a special case of estimation for model (1) – (2).

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