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имени Н.Э. Баумана

Г.П. Курчаткина, И.В. Цайтлер

Обучение чтению литературы на английском языке по специальности «Системы автоматического управления»

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Во второе пособие по специальности «Системы автоматического управления» авторы включили оригинальные тексты из американских и британских научных изданий, посвященные проблемам классической и современной теории управления, а также лексико-грамматические задания и упражнения, позволяющие усвоить соответствующую терминологию, развить и закрепить навыки чтения и перевода научно-технической литературы на английском языке.

Для студентов 3-го курса, обучающихся по специальности «Системы автоматического управления».

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Галина Павловна Курчаткина
Ирина Владимировна Цайтлер

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Редактор *Н.М. Маслова*
Корректор *Л.И. Малютина*
Компьютерная верстка *Е.В. Зимакова*

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ПРЕДИСЛОВИЕ

Второе пособие, написанное авторами по специальности «Системы автоматического управления», позволяет совершенствовать навыки чтения и перевода оригинальной научно-технической литературы в целях получения нужной информации и ее обобщения, а также приобрести навыки, необходимые для ведения бесед по темам прочитанных текстов.

Все тексты пособия взяты из оригинальной американской и британской литературы, они сокращены и в некоторых случаях незначительно адаптированы. Отобранные материалы посвящены различным проблемам классической и современной теории управления. В процессе работы студенты получат возможность овладеть терминологией, расширить и углубить знания по изучаемой специальности. Стилистическая разноплановость текстов и их объем, а также предполагаемые формы работы позволяют моделировать условия реальной информационно-поисковой деятельности специалиста.

Пособие состоит из трех разделов, каждый из которых содержит три учебных текста. Тексты *А* предназначены для формирования навыков изучающего чтения. Тексты *В* нацелены на развитие навыков чтения книг и достаточно больших и сложных в информативном и языковом планах научных статей для извлечения основной информации по определенному алгоритму и последующего ее устного обобщения в реферативной форме. Тексты *С* способствуют формированию навыков ознакомительного чтения и расширению словарного запаса.

Относящиеся к текстам упражнения направлены на усвоение активной лексики, закрепление грамматических конструкций и стилистических приемов, характерных для научно-технической литературы. В конечном счете эти упражнения нацелены на творческую работу с информацией, полученной из иностранных источников (монографий, статей, справочников).

В конце каждого раздела дан словарь (Essential Vocabulary), содержащий новые для студентов специальные термины и общеупотребительную лексику, необходимые для понимания и перевода текстов. Разумеется, помимо этих словарей студентам следует использовать разнообразные словари, изданные как в нашей стране, так и за рубежом.

Пособие предназначено для студентов 3-го курса, обучающихся по специальности «Системы автоматического управления».

UNIT 1

TASK 1. *Read and translate the text using Essential Vocabulary and a dictionary.*

Text IA. Control Theory

Control engineering has taken several major steps forward at crucial events in history. Each of these steps has been matched by a corresponding burst of development in the underlying theory of control.

Early on, when the compelling concept of feedback was applied, engineers sometimes encountered unexpected results. These then became catalysts for rigorous analysis. For example, if we go back to Watt's fly-ball governor, it was found that, under certain circumstances, these systems could produce self-sustaining oscillations. Toward the end of the 19th century, several researchers (including Maxwell) showed how these oscillations could be described via the properties of ordinary differential equations.

The developments around the period of the Second World War were also matched by significant developments in Control theory. For example, the pioneering work of Bode, Nyquist, Nichols, Evans and others appeared at that time. This resulted in simple graphical means for analyzing single-input, single-output feedback control problems. These methods are now generally known by the generic term Classical Control theory.

Classical Control theory was naturally couched in the frequency domain and the s-plane. Relying on transform methods, it is primarily applicable for linear time-invariant systems, though some extensions to nonlinear systems were made using, for instance, the describing function.

The system description needed for controls design is the magnitude and phase of the frequency response. This is advantageous since the frequency response can be experimentally measured. The transfer function can then be computed. For root locus design, the transfer function is needed. An exact description of the internal system dynamics is not needed for classical design; that is, only the input/output behavior of the system is of importance. The design may be carried out by hand using graphical techniques. These methods impart a great deal of intuition and afford the controls designer with a range of design possibilities, so that the resulting control systems are not unique. The design process here is an engineering art.

The 1960's saw the development of an alternative state space approach to control. This followed the publication of work on optical estimation and control by Wiener, Kalman, etc. This work allowed multivariable problems to be treated in a unified fashion. This had been difficult, if not impossible, in the classical framework. This set of developments is loosely termed Modern Control theory. With all its power and advantages, modern control was lacking in some aspects. The guaranteed performance obtained by solving matrix design equations means that it is often possible to design a control system that works in theory without gaining any engineering intuition about the problem.

Another problem is that a modern control system with any compensation dynamics can fail to be robust to disturbances, unmodelled dynamics and measurement noise. On the other hand, robustness is built in with a frequency – domain approach using notions like the gain and phase margin.

Thus these various approaches to control reached a sophisticated level and emphasis then shifted to other related issues, including the effect of model error on the performance of feedback controllers. This can be classified as the period of Robust Control theory.

There have been numerous other developments including adaptive control, autotuning and intelligent control.

TASK 2. *Read and translate the following words*:

major, crucial, rigorous, circumstance, generic, exact, techniques, unique, disturbance, margin.

TASK 3. *Complete the table*:

Noun	Verb	Adjective
development	–	–
–	apply	–
–	describe	–
–	–	significant
difference	–	–
extension	–	–
–	–	advantageous
–	measure	–
alternative	–	–

TASK 4. *Translate the following word combinations. Compose sentences with them.*

Major steps forward; crucial events in history; burst of development; unexpected results; exact description; multivariable problems; engineering intuition; sophisticated level.

TASK 5. *Give definitions to the following word combinations*:

rigorous analysis, differential equations, pioneering work, controls designer, autotuning control.

TASK 6. *Match the verbs and the prepositions and translate them. Compose sentences with the resulting phrasal verbs.*

to match to go back to result to carry to afford to lack to shift	to, in, out, by, with

TASK 7. *Make up sentences with suggested elements using the preposition* ***under****.*

The substance The systems The solution The properties The state The assumption	to be under	some pressure various conditions special circumstances the action of the influence of

TASK 8. *Translate the following phrases*:

при высоких температурах; со скоростью 300 000 км/с; при нормальном атмосферном давлении; с постоянной частотой; при высоких энергиях.

Note: Remember that you should use the preposition ***at*** with the words: temperature, energy, speed, velocity, voltage, rate, intensity.

TASK 9. *Translate the sentences into English.*

1. При каких обстоятельствах это произошло?
2. Реакция протекает (to proceed) при нормальном давлении и при комнатной температуре.
3. Открытие было сделано при следующих обстоятельствах.
4. Радиосигналы посылались с постоянной частотой.
5. Этот закон справедлив только при некоторых условиях.
6. В нашем опыте газ находился под большим давлением.

TASK 10. *Find English equivalents for the following phrases and word combinations*:

to encounter unexpected results; to be couched in the frequency domain and the s-plane; to carry out the design by hand; engineering art; claimed theory; to shift emphasis to other reached issues.

TASK 11. *Answer the questions.*

1. What crucial events in history connected with control engineering can you name?
2. How could unexpected results sometimes become catalysts for new analysis?
3. In what way did the Second World War influence the developments in control theory?
4. Why can the frequency response be regarded as advantageous?
5. Why is intuition so important for controls designer?
6. Does Modern Control Theory have any disadvantages? Which ones?
7. Can you explain the necessity of Robust Control Theory?
8. What new control theory developments do you know?

TASK 12. *Speak about different methods of Control Theory.*

TASK 13. *Read the text using Essential Vocabulary and a dictionary to know its content in detail. Complete the tasks that follow.*

Text IB. Basic Concepts of Control Theory

The concepts of control theory are simple and application-independent. This universality of control theory means that it is best considered as applied to an abstract situation called a system. It is this generality which constitutes the core idea of control theory: the high level of abstraction allows for control theory to be applicable to any situation with greater specificity.

Control theory concerns itself with means by which to alter the future behavior of systems (clearly the past cannot be influenced nor, since no response can take place in any system in zero time, can the present). Furthermore, the objective of any control system in every case is connected with the performance of the system over some period of time. For control theory to be successfully applied there needs to be at least two possible actions at any stage in the control system as the system would follow an unchangeable course otherwise. In addition, control theory also needs access to some means of choosing the correct (or most applicable) actions that will result in the desired behavior being produced.

Control theory was developed to support the emergent activity of automatic control. A central idea of control theory is the control loop, labeled as information channel in Fig. 1.

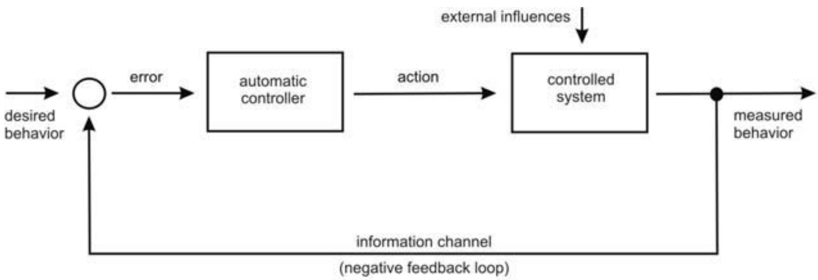

Fig. 1. Automatic process control using a negative feedback (control) loop

In the broadest form, a control loop operates on the principles of negative feedback. The effects of an action are reported to the controller through an information channel. The controller strives to minimize the error difference between the measured and the desired behaviors and commands the next action appropriately. A straight-forward example of this control concept is the cruise control feature of a car: if the measured speed of the car drops below the set speed (because of an uphill stretch), the cruise controller will accelerate; if the car rolls too fast, the controller will shift down in an attempt to minimize the discrepancy between the desired and the measured speeds.

Historically, automatic control was concerned with the replacement of a human worker in a manually controlled process with an automatic controller supervised by a human being. The control loop of the manually steered process was closed by the operator, who manipulated levers and switches in an attempt to assimilate the measured behavior (as displayed by the control panel) with the desired one. However, human control is expensive and subject to human errors. Furthermore, there exist a number of situations in which a human control loop is not possible, or at least not feasible, be it due to dangerous circumstances or small scales.

All control loops have the same basic form, regardless of the particular application area. Thus, control theory can be considered to concentrate on studying the universal situations that underlie all applications of quantitative control.

TASK 14. *Thoroughly read paragraphs 1 and 2 and define their main points.*

TASK 15. *Thoroughly read paragraphs 3, 4 and 5 and condense their content.*

TASK 16. *Summarize paragraphs 1 and 2 in no more than three sentences. Begin with:* The text provides information on…

TASK 17. *Compress paragraphs 3, 4 and 5 into a statement begining with the phrases*:

The text describes a central idea of…
It is reported that…
The text claims that...

TASK 18. *After reading the following guidelines summarize the text.*

Guidelines for Making Summaries

1. Read the text through carefully – the importance of this reading period cannot be overemphasized. You really need to “think yourself into the theme” of the text and ensure a complete grasp of the topic before continuing.

2. Determine the structure of the text and divide it into sections or stages of thought. The author's use of paragraphing will often be a useful guide.

3. Distinguish between more important and less important information and highlight key ideas and terms which should be included in your summary.

4. Make one-sentence summaries of each stage of thought and combine them eliminating repetition and less important information. Disregard minor details or generalize them. Use your own words avoiding the language of the original text wherever possible. Use as few words as possible to convey the main idea.

5. Use transitional words and phrases where necessary to ensure coherence. Combine sentences for a smooth, logical flow of ideas. Pay attention to grammar.

Transitional Words and Phrases

to add ideas	in addition, moreover, furthermore, another, as well as, and, also, besides, or
to compare	similarly, likewise, in much the same way
to contrast	but, yet, on the other hand, in contrast, still, nevertheless, otherwise, however, nonetheless, instead, rather than, unlike, conversely, whereas, even so, on the contrary
to concede	although, even though, though, doubtless
to give examples	for example, for instance, in particular, a case in point, as an illustration of, in general, whenever, frequently, usually, specifically
to emphasize	indeed, in fact, certainly, clearly, of course, to be sure, naturally, as a matter of fact, more important, most important, frankly, oddly enough, in any case, in other words, to put it another way
to show results	thus, therefore, hence, then, consequently, because, due to, as a result, since, it follows , and so, accordingly, as
to show sequence	first, second, third, next, then, after

to show time	before, after, until, while, since, when, currently, next, meanwhile, thereafter, soon, earlier, later, immediately, by that time, shortly, at that moment
to conclude	so, in conclusion, finally, in short, to sum up, therefore, on the whole, in brief, all in all

TASK 19. *Read the text using Essential Vocabulary. Find definitions to the concepts* ***observability****,* ***situatedness*** *and* ***controllability****.*

Text IC. Observability and Controllability

Observability and controllability are the main issues in the analysis of a system before deciding the best control strategy to be applied.

Observability refers to the accessibility of the controlled object's state in the environment. Assuming that there exist no limitations on the communication from the controlled object to the controller, observability mainly manifests in the object's capability to translate its environmental perception into a state vector. This translation process may involve the integration of different types of sensors, and therefore information, as well as dealing overlaps between sensor data (which may well be used to increase robustness of the data). The controlled object, in the first place, needs to be able to extract the information out of its environment which the controller needs in order to instantiate the necessary control process.

The ability to extract information out of the environment relates directly to the problem of situatedness. Situatedness is the property which allows an entity to acquire information about its surroundings through its sensors in interaction with the environment. Surely it is impossible for any entity to extract all information from its environment, and human beings definitely do not do so.

Observability can also be described as the capability of the controlled object to provide the information needed by the controller to compute an appropriate control vector, given the task and the desired behavior. High observability is generally only exhibited by relatively simple systems, whereas complex systems tend to have a very low degree of observability.

Controllability refers to the capability of the controlled object to move to a desired state. An object has a low degree of controllability if it cannot move to a desired state in one control step. The simple example of a wheeled robot exhibits a low degree of controllability when the goal of the control system is to move the robot upstairs. However, if the goal involved only leveled navigation in an open space, this particular robot would possess a higher degree of controllability.

In a basic control system, controllability is a necessary precondition for control by feedback loops. When the controller detects a deviation of the measured behavior from the expected behavior, it needs to take immediate counter-action. Low degrees of controllability almost always translate to instability of the control system. Conceptually, one may compare this to a large ship, which has a great amount of inertia. If the ship's motors attempt to stop the ship right as it reaches its goal position, the ship will run over and its position will have to be readjusted because the ship's inertia causes it to have a very low degree of controllability. The solution would be to reverse the motors a mile or two before the ship reaches the goal position.

TASK 20. *Answer the questions.*

1. What are the main issues when choosing the best control strategy?
2. What does observability refer to?
3. What does the translation process mentioned involve?
4. What is high observability typical of?
5. How can an entity acquire information about its surroundings?
6. What is controllability related to?
7. Why is controllability a necessary precondition for control by feedback loops?
8. How do low degrees of controllability affect control system stability?

Essential Vocabulary

access [´ækses] *n*	доступ
accessibility *n*	доступность, досягаемость
activity *n*	функционирование, работа
adaptive control	адаптивное управление; устройство адаптивного управления
autotuning *n*	автонастройка
control [kən´trəul] loop	схема управления; цепь управления
controllability *n*	управляемость, регулируемость
controlled object	объект управления

course *n*	ход, течение; линия поведения, образ действия
desired value	заданная величина; требуемое значение
deviation *n*	отклонение
discrepancy *n*	несоответствие, расхождение
disturbance *n*	нарушение (работы, работоспособности), помеха
entity *n*	объект
frequency domain	частотная область
frequency response	частотная реакция; частотная характеристика
intelligent control	интеллектуальное управление; интеллектуальное устройство управления
in zero time	*зд*. мгновенно, немедленно
label *v*	помечать, обозначать
linear time-invariant system	линейная не изменяемая во времени система
measured [´meʒəd] value	фактическое значение, полученное значение
multivariable *a*	с несколькими переменными, зависящий от многих переменных
negative feedback	отрицательная обратная связь
observability *n*	возможность наблюдения
overlap *n*	совпадение, взаимное наложение; перекрытие
phase margin	фазовый запас, запас устойчивости по фазе
quantitative [´kwɔntıtətıv] control	количественное управление, количественное регулирование
robust control	робастное регулирование, робастное управление
robustness [rəu´bʌstnıs] *n*	надежность; устойчивость, робастность
root-locus design	построение корневого годографа
self-sustaining oscillations	самоподдерживающиеся колебания
single input, single output	система «один вход, один выход»
situatedness *n*	ситуативность

s-plane *n*	s-плоскость
state *n*	состояние, положение
state space approach	метод пространства состояний
switch *n*	переключатель
transfer function	передаточная функция
transform method	метод преобразований
translate *v*	преобразовывать
zero reaction time	мгновенное реагирование, мгновенное срабатывание

UNIT II

TASK 1. *Read and translate the text using Essential Vocabulary and a dictionary.*

Text IIA. Adaptive Control

Adaptive Control is a technique of applying some system identification technique to obtain a model of the process and its environment from input-output experiments and using this model to design a controller. The parameters of the controller are adjusted during the operation of the plant as the amount of data available for plant identification increases. However, when the number of parameters is larger than three or four and they vary with time, automatic adjustment is needed. The design techniques for adaptive systems are studied and analysed in theory for unknown but fixed plants. In practice, they are applied to slowly time-varying and unknown plants.

Research in adaptive control has a long and vigorous history. In the 1950s, it was motivated by the problem of designing autopilots for aircraft operating at a wide range of speeds and altitudes. The 1960s marked an important time in the development of control theory and adaptive control in particular. The dynamic programming, learning schemes, system identification (off-line) were thoroughly researched and understood. The 1970s and mainly 1980s have proven to be a time of critical examination and evaluation of the accomplishments to date. It was pointed out that the assumptions under which stability of adaptive schemes had been proven were very sensitive to the presence of unmodelled dynamics, typically high-frequency parasitic models that were neglected to limit the complexity of the controller. The implementation of complicated nonlinear laws inherent in adaptive control has been greatly facilitated by the boom in microelectronics and today, one can talk in terms of custom adaptive controller chips. All this flood of research and development is bearing fruit and the industrial use of adaptive control is growing.

One of the earliest and most intuitive approaches to adaptive control is gain scheduling. The idea is to find auxiliary process variables that correlate well with the changes in process dynamics. It is then possible to compensate for plant parameter variations by changing the parameters of the regulator as functions of the auxiliary variables.

The advantage of gain scheduling is that the parameters can be changed quickly in response to changes in the plant dynamics. It is convenient especially if the plant dynamics depends in a well-known fashion on a relatively few easily measurable variables. Although gain scheduling is extremely popular in practice, the disadvantage of it is that it is an open-loop adaptation scheme, with no real "learning" or intelligence. Further, the extent of design required for its implementation can be enormous.

A truly adaptive controller is capable of learning from previous events to improve future performance. This can be achieved in many different ways, but a common feature of all adaptive controllers is that they have a much "longer" memory than a normal PID regulator. There are basically four different types of regulators which are often referred as adaptive:

1) PID with gain scheduling, in which the control parameters are changed during running as a predefined function of process measurements (it is not truly adaptive one).

2) Autotuner, which is often a PID controller where the control parameters are automatically tuned only at commissioning (not truly adaptive, as well).

3) Adaptive PID, where the small number of parameters makes the construction easier for the supplier, but many of the advantages with adaptive control can not be used since the controller structure is too simple (it is truly adaptive).

4) General adaptive regulators which are designed to control more or less any type of process. There is no real limitation of the number control parameters other than maybe from a practical point of view (this one is truly adaptive).

TASK 2. *Read and translate the following words*:

technique, vigorous, scheme, flood, auxiliary, altitude, intelligence

TASK 3. *Match the two halves of the word combinations used in text IIA.*

(1) input-output	(a) adjustment
(2) automatic	(b) history
(3) design	(c) approach
(4) vigorous	(d) experiments
(5) dynamic	(e) techniques
(6) intuitive	(f) programming

TASK 4. *Complete the table*:

Noun	Verb	Adjective
identification	–	–
–	adjust	–
–	motivate	–
evaluation	–	–
–	–	accomplished
–	limit	–
–	–	variable
–	–	correlated
–	–	convenient
–	improve	–
performance	–	–
–	refer	–
definition	–	–

TASK 5. *Fill the blanks with two nouns to get new word combinations. Compose your own sentences with them.*

1. to obtain a model _________ , _________ .
2. amount of data _________ , _________ .
3. research in adaptive control ___________ , _________ .
4. wide range of speeds _________ , _________ .
5. critical examination and evaluation ________ , ________ .
6. complexity of the controller ___________ , _________ .
7. auxiliary process variable ___________ , _________ .
8. capable of learning __________ , __________ .

TASK 6. *Give the plural of the underlined words.*

1. I am concerned with their phenomenon.
2. The formula has been verified in a variety of experiments.
3. The analysis of experiments suggests some new ideas.
4. The heavier the nucleus, the denser are the energy levels.
5. The radius of the tubes has been measured.
6. This criterion ought to be satisfied.
7. Do you know any hypothesis concerned with this problem?

TASK 7. *Translate the following prepositional phrases. Compose sentences with them.*

To vary with time; to apply to; to point out; to be sensitive to; to be inherent in; to correlate with; to compensate for; to depend on; to be capable of.

TASK 8. *Find in the text the equivalents for the given Russian words and word combinations. Compose sentences with them.*

Однако; на практике; в особенности; тщательно; с точки зрения; в ответ на…; хотя, более того; так как; точка зрения.

TASK 9. *A. Translate the following words with negative prefixes*: unknown plants, unmodelled dynamics, disadvantage.

B. Make the words negative with the help of prefixes ***ab, un, im, in***.
Sensitive, possible, measurable, popular, truly, common, normal, real.

TASK 10. *Answer the questions.*

1. What technique can be called adaptive control?
2. What is the history of adaptive control research?
3. What do you know about gain scheduling? What are its advantages and disadvantages?
4. What is a truly adaptive controller?
5. What types of regulators can you name?

TASK 11. *Speak about adaptive control.*

TASK 12. *Read the text using Essential Vocabulary and a dictionary to know its content in detail. Complete the tasks that follow.*

TEXT IIB. Robust Control

Robust control refers to the control of unknown plants with unknown dynamics subject to unknown disturbances. The key issue with robust control systems is uncertainty and how the control system can deal with this problem

Control system engineers are concerned with three main topics: observability, controllability and stability. Observability is the ability to observe all of the parameters or state variables in the system. Controllability is the ability to move a system from any given state to any desired state. Stability is often phrased as the bounded response of the system to any bounded input. Any successful control system will have and maintain all three of these properties. Uncertainty presents a challenge to the control system engineer who tries to maintain these properties using limited information.

One method to deal with uncertainty in the past was stochastic control. In stochastic control, uncertainties in the system are modeled as probability distributions. This method deals with the expected value of control. Abnormal situations may arise that deliver results that are not necessarily close to the expected value. This may not be acceptable for embedded control systems that have safety implications.

Robust control methods seek to bound the uncertainty rather than express it in the form of a distribution. Given a bound on the uncertainty, the control can deliver results that meet the control system requirements in all cases. Therefore robust control theory might be stated as a worst-case analysis method rather than a typical case method. It must be recognized that some performance may be sacrificed in order to guarantee that the system meets certain requirements.

One of the most difficult parts of designing a good control system is modeling the behavior of the plant. There are a variety of reasons for why modeling is difficult, namely imperfect plant data, time varying plants, higher order dynamics, non-linearity, complexity and different professional skills.

In an embedded system, computation resources and cost are a significant issue. The issue for the control engineer is to synthesize a model that is simple enough to implement within these constraints but performs accurately enough to meet the performance requirements. The robust control engineer also wants this simple model to be insensitive to uncertainty.

One technique for handling the model uncertainty that often occurs at high frequencies is to balance performance and robustness in the system through gain scheduling. A high gain means that the system will respond quickly to differences between the desired state and the actual state of the plant. At low frequencies where the plant is accurately modeled, this high gain (near 1) results in high performance of the system.

TASK 13. *Name the paragraph that gives the definition of robust control.*

TASK 14. *Name the paragraphs that provide information on the effects of uncertainty.*

TASK 15. *Name the paragraphs that describe modeling the behavior of the plant.*

TASK 16. *Give the definition of robust control.*

TASK 17. *Present the information on the effects of uncertainty. Begin with*:

The text considers the effects of uncertainty. It is emphasized that…

TASK 18. *Present the information on modeling the behavior of the plant using the following phrases*:

The text reports on the difficulties of…
Attention is given to such technique as…

TASK 19. *Summarize the text using the guidelines from Unit I.*

TASK 20. *Read the text using Essential Vocabulary. Ask 10 relevant questions.*

TEXT IIC. Intelligent Learning Control

Learning is an important attribute of intelligent control. Highly autonomous behavior is a very desirable characteristic of advanced control systems so they perform well under changing conditions in the plant and the environment without external intervention. This requires the ability to adapt to changes affecting, in a significant manner, the operating region of the system. Adaptive behavior of this type is not typically offered by conventional control systems. Additional decision-making abilities should be added to meet the increased control requirements. The controller's capacity to learn from past experience is an integral part of such highly autonomous controllers. The goal of introducing learning methods in control is to broaden the region of operability of conventional control systems. Therefore, the ability to learn is one of the fundamental attributes of autonomous intelligent behavior.

The ability of man-made systems to learn from experience and, based on that experience, improve their performance is the focus of machine learning. Learning can be seen as the process whereby a system can alter its actions to perform a task more effectively due to increases in knowledge related to the task. The actions that a system takes depend on the nature of the system. For example, a control system may change the type of controller used, or vary the parameters of the controller, after learning that the current controller does not perform satisfactorily within a changing environment. Similarly, a robot may need to change its visual representation of the surroundings after learning of new obstacles in the environment. The type of action taken by the machine is dependent upon the nature of the system and the type of learning system implemented. The ability to learn entails such issues as knowledge acquisition, knowledge representation, and some level of inference capability. Learning, considered fundamental to intelligent behavior, and in particular the computer modeling of learning processes has been the subject of research in the field of machine learning for the past 25 years.

Essential Vocabulary

actual state	реальное/фактическое состояние
advanced control system	усовершенствованная/современная система управления
attribute *n*	свойство; характеристика
auxiliary variable	вспомогательная переменная
constraint *n*	ограничение, ограничительное условие
decision making	принятие решения
embedded control system	встроенная система управления
gain scheduling [´ʃedju:lɪŋ]	управление коэффициентом усиления
inference [´ɪnfərəns] *n*	умозаключение, вывод, заключение
knowledge acquisition	приобретение знаний
knowledge representation	представление знаний
learning control	управление с самообучением; устройство экспертного управления
machine [mə´ʃi:n] learning	машинное обучение, обучение машины
non-linearity *n*	нелинейность
operating region	рабочая область; рабочий диапазон

PID (proportional-integral-derivative) regulator	ПИД-регулятор (пропорционально-интегрально-дифференциальный)
plant *n*	объект управления; установка
probability distribution	распределение вероятностей
state variable [´veərıəbəl]	переменная состояния
stochastic [stəu´kæstık] control	стохастическое управление
system identification	идентификация системы
time varying	динамический, изменяющийся во времени
unmodelled dynamics	немоделируемая динамика

UNIT III

TASK 1. *Read and translate the text using Essential Vocabulary and a dictionary.*

Text IIIA. Fuzzy Logic and Fuzzy Control

Fuzzy Logic has emerged as a profitable tool for the controlling of subway systems and complex industrial processes, as well as for household and entertainment electronics, diagnosis systems and other expert systems. Although Fuzzy Logic was invented in the United States, the rapid growth of this technology has started from Japan and has now again reached the USA and Europe also.

Fuzzy has become a key-word for marketing. Electronic articles without Fuzzy-component gradually turn out to be dead stock. Fuzzy Logic is basically a multivalued logic that allows intermediate values to be defined between conventional evaluations like “yes/no”, “true/false”, “black/white”, etc. Notions like “rather warm” or “pretty cold” can be formulated mathematically and processed by computers. In this way an attempt is made to apply a more human-like way of thinking in the programming of computers.

The very basic notion of fuzzy systems is a Fuzzy (sub)set. In classical mathematics we are familiar with what we call crisp sets. Similar to the operations on crisp sets we also want to intersect, unify and negate fuzzy sets. The minimum operator for the intersection and the maximum operator for the union can be suggested of two fuzzy sets.

Fuzzy controllers are the most important applications of fuzzy theory. They work rather different than conventional controllers; expert knowledge is used instead of differential equations to describe a system. This knowledge can be expressed in a very natural way using linguistic variables which are described by fuzzy sets.

The employment of Fuzzy Control is commendable 1) for very complex processes, when there is no simple mathematical model; 2) for highly non-linear processes; 3) if the processing of (linguistically formulated) expert knowledge is to be performed. Although, it is no good idea if 1) conventional control theory yields a satisfying result; 2) an easily solvable and adequate mathematical model already exists; 3) the problem is not solvable.

Following is the base on which fuzzy logic is built.

As the complexity of a system increases, it becomes more difficult and eventually impossible to make a precise statement about its behavior, eventually arriving at a point of complexity where the fuzzy logic method born in humans is the only way to get the problem.

Human beings have the ability to take in and evaluate all sorts of information from the physical world they are in contact with and to mentally analyze, average and summarize all this input data into an optimum course of action. All living things do it, but humans do it more and do it better and have become the dominant species of the planet. If you think about it, much of the information you take in is not very precisely defined. We call it "fuzzy input". However, some of your "input" is reasonably precise and non-fuzzy. Your processing of all this information is not very precisely definable and is called "fuzzy processing". Fuzzy logic theorists would call it using fuzzy algorithms (algorithm is another word for procedure or program, as in computer program). Fuzzy logic control and analysis systems may be electro-mechanical in nature or concerned only with data.

Other applications which have benefited through the use of fuzzy systems theory have been information retrieval systems, a navigation system for automatic cars, a predicative fuzzy-logic controller for automatic operation of trains, laboratory water level controllers, controllers for robot arc-welders, feature-definition controllers for robot vision, graphics controllers for automated police sketchers, and more.

TASK 2. *Read and translate the words*: fuzzy, emerge, diagnosis, yield, precise, theorist, procedure, arc, species.

TASK 3. *Translate the following word combinations and use them in the sentences of your own.*

> Profitable tool; household and entertainment electronics; dead stock; multivalued logic; intermediate value; human-like way of thinking; very basic notion; expert knowledge; linguistic variable; satisfying result; precise statement; input data; optimum course of action; dominant species; information retrieval system; predicative fuzzy-logic controller; robot arc-welder; automated police sketchers.

TASK 4. *Fill the blanks with two words to get new combinations. Compose sentences with them.*

(1) profitable tool for controlling ________ , ________ .
(2) rapid growth of technology ________ , ________ .
(3) key-word for marketing ________ , ________ .
(4) reasonably precise ________ , ________ .
(5) electro-mechanical in nature ________ , ________ .
(6) have the ability to take in and evaluate _______ , _______ .

TASK 5. *Complete the table*:

Noun	Verb	Adjective
–	emerge	–
–	–	profitable
entertainment	–	–
–	invent	–
–	–	conventional
–	intersect	–
uniformity	–	–
–	–	satisfying
–	–	solvable
–	exist	–
complexity	–	–
–	–	precise
–	average	–
–	–	definable

TASK 6. *Choose the necessary preposition. Compose sentences with the resulting phrases.*

to be familiar, similar, in contact to arrive, to concern	at, to, with

TASK 7. *Find English equivalents for the following phrases*:

to emerge as a profitable tool for the controlling; to become a key-word for marketing; a more human-like way of thinking; ability to mentally analyze, average and summarize; to become the dominant species of the planet; automated police sketchers.

TASK 8. *Answer the questions*.

1. What do you know about the history of Fuzzy Logic?
2. Why is Fuzzy a key-word for marketing?
3. What is the very basic notion of fuzzy systems?
4. What can you say about Fuzzy Controllers?
5. Where is the employment of Fuzzy Control commendable? Where not?
6. What is the base on which fuzzy logic is built?
7. In what way do human beings take in and evaluate information?
8. What is “fuzzy input”?
9. What applications of fuzzy systems theory can you name?

TASK 9. *Speak about Fuzzy Logic and Fuzzy Control.*

TASK 10. *Look through the text and say into how many stages of thought it can be divided. Give a title to each stage.*

Text IIIB. Artificial Neural Networks

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous system, such as the brain, processes information. The key element of this paradigm is the novel structure of the information processing system. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process.

Neural network simulations appear to be a recent development. However, this field was established before the advent of computers, and has survived at least one major setback and several eras. Following an initial period of enthusiasm, the field survived a period of frustration and disrepute. During this period when funding and professional support was minimal, important advances were made by relatively few researchers. The first artificial neuron was produced in 1943 by the neurophysiologist Warren McCulloch and the logician Walter Pits. But the technology available at that time did not allow them to do too much. Currently, the neural network field enjoys a resurgence of interest and a corresponding increase in funding.

Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an “expert” in the category of information it has been given to analyse. This expert can then be used to provide projections given new situations of interest and answer "what if" questions. Other advantages include: adaptive learning, self-organisation, real time operation, fault tolerance (via redundant information coding).

Neural networks take a different approach to problem solving than that of conventional computers. Conventional computers use an algorithmic approach, i.e. the computer follows a set of instructions in order to solve a problem. Unless the specific steps that the computer needs to follow are known the computer cannot solve the problem. That restricts the problem solving capability of conventional computers to problems that we already understand and know how to solve.

Neural networks process information in a similar way the human brain does. The network is composed of a large number of highly interconnected processing elements (neurons) working in parallel to solve a specific problem. Neural networks learn by example. They cannot be programmed to perform a specific task. The examples must be selected carefully otherwise useful time is wasted or, even worse, the network might be functioning incorrectly. The disadvantage is that because the network finds out how to solve the problem by itself, its operation can be unpredictable.

Still neural networks and conventional algorithmic computers are not in competition but complement each other. Even more, a large number of tasks require systems that use a combination of the two approaches (normally a conventional computer is used to supervise the neural network) in order to perform at maximum efficiency.

TASK 11. *Reread the text to know its content in detail. Use Essential Vocabulary and a dictionary. Complete the tasks that follow.*

TASK 12. *Condense the content of each stage of thought in no more than three sentences.*

TASK 13. *Summarize the text using the given phrases. Before doing this reread the guidelines from Unit 1.*

The text is about…
The historical background of… is presented.
The text touches upon…
Much attention is given to difference between…
It is recognized that…

TASK 14. *Read the text using Essential Vocabulary. Ask 10 relevant questions.*

Text IIIC. Artificial Neural Networks in Practice

Neural networks have broad applicability to real world business problems. Since they are best at identifying patterns or trends in data, they are well suited for prediction or forecasting needs including: sales forecasting, industrial process control, customer research, data validation, risk management and target marketing. In fact, neural networks have already been successfully applied in many industries.

Artificial Neural Networks (ANN) are currently a "hot" research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. At the moment, the research is mostly on modeling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc.).

Neural networks are ideal in recognizing diseases using scans since there is no need to provide a specific algorithm on how to identify the disease. Neural networks learn by example so the details of how to recognize the disease are not needed. What is needed is a set of examples that are representative of all the variations of the disease. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

An application developed in the mid-1980s called the "instant physician" trained an autoassociative memory neural network to store a large number of medical records, each of which includes information on symptoms, diagnosis, and treatment for a particular case. After training, the net can be presented with input consisting of a set of symptoms; it will then find the full stored pattern that represents the "best" diagnosis and treatment.

Business is a diverted field with several general areas of specializations such as accounting or financial analysis. Almost any neural network application would fit into a business area or financial analysis. There is also a strong potential for using neural networks for business purposes like resource allocation and scheduling.

There is a marketing application which has been integrated with a neural network system. The Airline Marketing Tactician (a trademark abbreviated as ATM) is a computer system made of various intelligent technologies including expert systems. A feedforward neural network was trained using back-propagation to assist the marketing control of airline seat allocations. The system is used to monitor and recommend booking advice for each departure. Such information has a direct impact on the profitability of an airline and can provide a technological advantage for users of the system.

ANN are also used in recognition of speakers in communications; recovery of telecommunications from faulty software; undersea mine detection; three-dimensional object recognition; hand-written word recognition and facial recognition.

Essential Vocabulary

accounting *n*	бухгалтерский учет
arc-welder	аппарат для дуговой сварки
artificial neural [ˌa:tɪ´fɪʃəl ´njuərəl] network (ANN)	искусственная нейронная сеть
autoassociative memory neural network	нейронная сеть с ассоциативной памятью
automated police sketcher	программа для составления фотороботов
back-propagation *n*	обратное распространение ошибки
CAT (computer-assisted tomography)	компьютерная томография
CAT scan	компьютерная томограмма
customer research	изучение клиентуры
data validation	проверка данных
fault [fɔ:lt] tolerance	устойчивость к повреждениям; сохранение работоспособности (при отказе отдельных элементов); надежность
faulty *a*	неисправный; несовершенный
feedforward neural network	нейронная сеть с прогнозированием
frustration *n*	разочарование, неудовлетворение; фрустрация
fuzzy (sub)set	нечеткое (под)множество
fuzzy control	нечеткое управление
intersect *v*	пересекать; перекрещивать; делить на части
negate *v*	отрицать, отвергать

paradigm [´pærədaɪm] *n*	парадигма; система понятий или воззрений
prediction *n*	прогноз; расчет; предвычисление
recognise *v*	распознавать; обнаруживать
recognition *n*	распознавание
recovery *n*	восстановление
redundant *a*	избыточный; дублирующий
resource allocation	распределение ресурсов
retrieval system	система автоматического поиска
risk management	управление риском; оценка риска
sales forecasting	прогнозирование продаж
scheduling [´ʃedju:lɪŋ] *n*	планирование
target marketing	целевой маркетинг

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