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PROFESSIONALLY ORIENTED FOREIGN (ENGLISH) LANGUAGE

Methodological guidelines for performing term papers

for students majoring in specialty 5B070200 – Automation and control
(Part II)

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The present methodological guidelines are intended for the 3-rd year students of specialty 5B070200 – Automation and control for performing term paper 1 on the discipline “Professionally oriented foreign (English) language”. Special attention is drawn to the translation of authentic professional texts, compilation of terminological vocabulary, as well as doing lexical and grammar exercises. Key-patterns and instructions on writing summaries to the texts are also given.

References- 8 items.

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Preface

The present methodical guidelines have been prepared within the framework of the discipline “Professionally-oriented English language”, and it contains basic requirements for performing and formatting of term paper №1.

Self-study of the student is aimed at individual fulfillment of academic assignments, generating cognitive interest, extending knowledge in the area of professional occupation through language-learning practice.

Term paper 1 (SSA – self-study assignment) consists in written translation of professionally-oriented texts with volume of no less than 3,000 symbols each, compiling a terminological glossary, and fulfillment of lexical and grammar assignments, and tasks for monitoring comprehension of the text, including writing of an abstract or a summary.

Generally, a term paper should be written in out-of class conditions, in accord with the suggested list of topics and the teacher’s assignments. One of the main tools for understanding the text content is its lexical and grammatical analysis which is applied while reading and checked in the process of fulfillment of the assignments.

Term paper assignments

1. Translate the text from English into Russian (volume – 3,000 symbols).
2. Compile a terminological glossary (no less than 20 per term paper).
3. Fulfill the task on text comprehension (for each term paper).
4. Fulfill the tasks on vocabulary and grammar (for each term paper).
5. Write a summary.

Criteria for evaluating translation skills (professionally-oriented texts)

It is generally accepted that the quality of the translation is assessed according to the following criteria:

- accuracy of the transmission of thought expressed in the original;
- compression of the form of presentation - implies not only brevity, but also the maximum approximation to the form and volume of the original text;
- clarity of presentation of thoughts;
- logical sequencing and clear presentation;
- terminological style and grammar accuracy;
- literacy - implies the necessity of observing all the norms of the literary language, the correct style of narration, the principles of euphoniousness, etc.

To perform a good translation into your native language, the translator needs four conditions:

a) vocabulary - knowledge of the minimum set of English most common words and expressions;

b) knowledge of grammar;

c) mastering the technique of translation - the ability to determine to which part of speech an unfamiliar word belongs, and to find its meaning in the dictionary;

d) knowledge of the area to which the translated text relates.

Work on the term paper (TP 1) starts on the first week of the semester, and the completed paper must be submitted on the 5th week.

The title page should be formatted according to the standard accepted in the University (consult the teacher).

It is also required to compile a student's vocabulary book. The format may be free, or you can use the sample of a vocabulary log presented here or choose any other suitable form from the Internet.

Sample Vocabulary Log

Word or concept	Part of speech/ word definition	Translation	Sentence or phrase using the word
State space	A compound noun. A mathematical model of a physical system as a set of input, output and state variables related by first order differential equations	Пространство состояний	The state space representation ….provides a convenient and compact way to model and analyze systems with multiple inputs and outputs…

When giving a definition to a term or special expression you should find the correct meaning of those offered by a dictionary, which corresponds to the meaning of the concept in the given text (context). For example, the word "representation" will be translated as «представление» (пространства состояний), but not as «изображение», «образ», «утверждение», «заявление», «протест», «делегация» или «показ на сцене». It is advisable to record all the course learning activities in a separate file (portfolio).

To write *a summary* you should use the following key-expressions:
The text/article under review…gives us a sort of information about…
The article deals with the problem…
The subject of the text is…
The text is about…

At the beginning (of the text) the author describes…(dwells on…; explains…; touches upon…; analyses…; comments…; characterizes…; underlines…; reveals…; gives account of...)

The article begins with the description of…; a review of…; the analysis of…

The article opens with…

Then (after that, further on, next) the author passes on to…; gives a detailed (thorough) analysis (description); goes on to say that…

To finish with (in conclusion, to sum up), the author describes…
At the end of the article, the author draws the conclusion that…the author sums it all up (by saying…)
In conclusion the author…

Besides, it should be noted that the material presented in the guidelines is not intended to develop the students' knowledge in their specialty, but exclusively for control and mastering their language competences. So, don't be strict in regard of the content, and try to focus on accuracy of translation and performing grammar and lexical assignments. Let's get started!

1 variant

1.1 Read and translate text A.

Text A. Automatic control theory

Automatic control is the application of concepts derived from the research area of modern control theory. Automatic control is also a technology for application of control strategies. The implementing requires prior analysis and modeling of the subject to be controlled. Automatic control covers all kinds of technical implementations for systems to save energy and to prevent from self-destroying.

Automatic control is the traditional technical base for mechanization and automation. Automatic control employs methods from control theory and from physics and is based on mathematics and engineering. The systems studied within automatic control design are mostly complex systems, for the ease of modeling partially reduced for the operational conditions to somewhat simplified or partial linear systems.

Designing a system with features of automatic control generally requires the feeding of e.g. electrical and/or mechanical energy to enhance the dynamic features of an otherwise sluggish or variant, even errant system. The control is applied with a controller, i.e. a computer regulating the energy feed.

Automatic control can self-regulate a technical plant (such as a machine or an industrial process) operating condition or parameters by the controller with minimal human intervention. A regulator such as a thermostat is an example of a device studied in automatic control.

A central concept with automatic control is that of the open system which is to be controlled, such as a rudder and its engine, a propeller and its motor or a ballistic missile with its jet or rocket engine and the feedback of control information from the measured speed, direction and heading in a closed loop to enable proper feed forward of propelling energy.

1) Sensor(s), which measure some physical state such as temperature or liquid level.

2) Controller(s), which may be from simple physical components up to complex special purpose digital controllers or embedded computers.

3) Actuator(s), which effect a response to the sensor(s) under the command of the responder, for example, by controlling an energy input, as e.g. a gas flow to a burner in a heating system or electricity to a motor in a refrigerator or pump.

Control theory is an interdisciplinary branch of engineering and mathematics that deals with the behavior of dynamical systems. The desired output of a system is called the reference. When one or more output variables of a system need to follow a certain reference over time, a controller manipulates the inputs to a system to obtain the desired effect on the output of the system.

The usual objective of control theory is to calculate solutions for the proper corrective action from the controller that result in system stability, that is, the system will hold the set point and not oscillate around it.

The input and output of the system are related to each other by what is known as a transfer function (also known as the system function or network function). The transfer function is a mathematical representation, in terms of spatial or temporal frequency, of the relation between the input and output of a linear time-invariant system.

Control theory is a theory that deals with influencing the behavior of dynamical systems; an interdisciplinary subfield of science, which originated in engineering and mathematics, and evolved into use by the social sciences, like psychology, sociology, criminology and in financial system.

Control systems can be thought of as having four functions: Measure, Compare, Compute, and Correct. These four functions are completed by five elements: Detector, Transducer, Transmitter, Controller, and Final Control Element. The measuring function is completed by the detector, transducer and transmitter. In practical applications these three elements are typically contained in one unit. A standard example is a Resistance thermometer.

The compare and computer functions are completed within the controller which may be completed electronically through a Proportional Control, PI Controller, PID Controller, Bistable, Hysteretic control or Programmable logic controller. The final control element changes an input or output in the control system which affect the manipulated or controlled variable.

Modern control theory.

In contrast to the frequency domain analysis of the classical control theory, modern control theory utilizes the time-domain state space representation, a mathematical model of a physical system as a set of input, output and state variables related by first-order differential equations. To abstract from the number of inputs, outputs and states, the variables are expressed as vectors and the differential and algebraic equations are written in matrix form (the latter only being possible when the dynamical system is linear). The state space representation (also known as the "time-domain approach") provides a convenient and compact way to model and analyze systems with multiple inputs and outputs. With inputs and outputs, we would otherwise have to write down Laplace transforms to encode all the information about a system. Unlike the frequency domain approach, the use of the state space representation is not limited to systems with linear components and zero initial conditions. "State space" refers to the space whose axes are the state variables. The state of the system can be represented as a vector within that space.

1.2 Answer the questions:

1) How can you define automation or automatic control?
2) What methods does the automatic control employ?
3) What is control theory?
4) What does the modern control theory utilize?
5) What are the functions fulfilled by the controller?
6) Is it true that the control theory is given birth in sociology?

1.3 Make up 5-7 questions of your own to the text.

1.4 In the text, find terms definitions or Russian equivalents of which are given below:

1) In control systems, h……..can be used to filter signals so that the output reacts less rapidly than it otherwise would, by taking recent history into account.
2) P**…………….** is a type of linear feedback ………. system in which a correction is applied to the controlled variable which is p………. to the difference between the desired value.
3) B………. means having two stable states.
4) Пропорционально-интегральный регулятор.
5) ………….. - a three term c…….., a control loop feedback mechanism widely used in industrial control systems and a variety of other applications requiring continuously modulated control.
6) A………….. is a device that converts energy from one form to another.
7) Usually a ………… converts a signal in one form of energy to a signal in another. They are often employed at the boundaries of automation, measurement, and control systems.

1.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Modeling; linear (systems); feeding; closed loop; sensor; controller; actuator; responder; reference; variable; transfer function; interdisciplinary; time-invariant;

transducer; detector; PLC; manipulated (describing a variable); differential; vector; domain approach.

1.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).
2) Write out sentences with Passive Voice (5-7).

1.7 Read text B and write a summary of it (not less than 7 sentences).

Text B. Feedback Systems

Feedback Systems process signals. The processing part of a feedback system may be electrical or electronic, ranging from a very simple to a highly complex circuits.

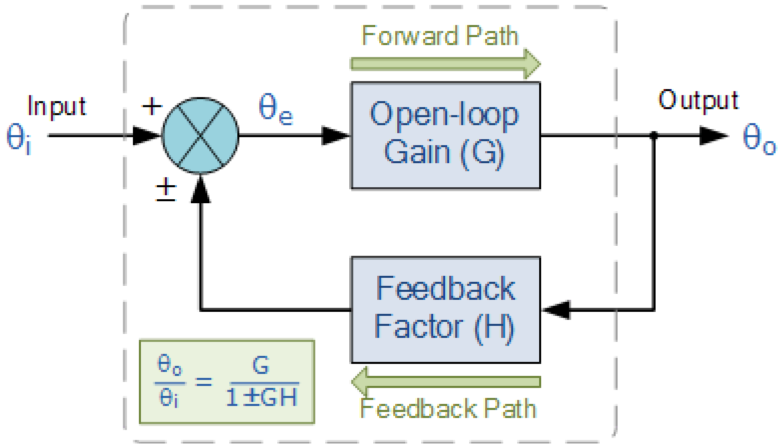
Simple analogue feedback control circuits can be constructed using individual or discrete components, such as transistors, resistors and capacitors, etc., or by using microprocessor-based and integrated circuits (IC's) to form more complex digital feedback systems.

As we have seen, open-loop systems are just that, open ended, and no attempt is made to compensate for changes in circuit conditions or changes in load conditions due to variations in circuit parameters, such as gain and stability, temperature, supply voltage variations and/or external disturbances. But the effects of these "open-loop" variations can be eliminated or at least considerably reduced by the introduction of *Feedback*.

A feedback system is one in which the output signal is sampled and then fed back to the input to form an error signal that drives the system. In the previous tutorial about closed-loop systems, we saw that in general, feedback is comprised of a sub-circuit that allows a fraction of the output signal from a system to modify the effective input signal in such a way as to produce a response that can differ substantially from the response produced in the absence of such feedback.

Feedback Systems are very useful and widely used in amplifier circuits, oscillators, process control systems as well as other types of electronic systems. But for feedback to be an effective tool it must be controlled as an uncontrolled system will either oscillate or fail to function. The basic model of a feedback system is given as:

Feedback System Block Diagram Model



This basic feedback loop of sensing, controlling and actuation is the main concept behind a feedback control system and there are several good reasons why feedback is applied and used in electronic circuits:

1) Circuit characteristics such as the systems gain and response can be precisely controlled.

2) Circuit characteristics can be made independent of operating conditions such as supply voltages or temperature variations.

3) Signal distortion due to the non-linear nature of the components used can be greatly reduced.

4) The frequency response, gain and bandwidth of a circuit or system can be easily controlled to within tight limits.

Whilst there are many different types of control systems, there are just two main types of feedback control namely: *Negative Feedback* and *Positive Feedback.*

2 variant

2.1 Read text A and translate it.

Text A. Integration of Sensors in Control and Automation Systems

Control theory is an interdisciplinary branch of engineering and mathematics dealing with the behavior of dynamic systems with inputs. The objective of control theory is to calculate solutions for the proper corrective action from the controller that results in system stability and improved performance. Automation and Industrial Control Systems (ICS) encompass many applications and uses of industrial and facility control and automation systems. Industrial Control Systems are defined as “a collection of personnel, hardware, and software that can affect or influence the safe, secure, and reliable operation of an industrial process.”

Control systems are composed by five main elements: sensors, transducers, transmitters, controllers, and final control elements or actuators. This special issue focuses on sensors and, more concretely, on sensor integration in automation and control systems. Let us remind you that a sensor is defined as a device that converts a physical stimulus into a readable output. The role of a sensor in a control and automation system is to detect and measure some physical effect, providing this information to the control system.

The integration of sensors in control and automation systems has received a great deal of attention from a considerable number of researchers and from the industrial community in the last years. Emphasis is placed on the importance of creating improvements in control and automation systems in order to meet the challenges of developing and refining new applications. These systems have to integrate a variety of sensory information and human knowledge for the sake of efficiently carrying out tasks with or without human intervention.

In fact, the integration of sensors into intelligent devices and systems has increased the capacity to measure, analyze, and aggregate data at a localized level. Autonomous and connected sensors are able to selectively sample and measure many physical properties. Built on the increasing capabilities of fixed-access and wireless networks, smart sensor developments allow the collection of raw data, which is processed into information and conveyed via a network connection.

The concept of sensor integration is close to the sensor fusion term, which is defined as “the art of processing data from multiple sensors with an aim to replicate a physical environment or induce intelligence to control a phenomenon with increased precision and reliability.” Sensor fusion or integration is evolving rapidly as the basis of robust control systems that can make sense of imperfect input despite the environment in which it operates. Data from multiple sensors are fused to increase response and accuracy, delivering control systems that until recently could only be theorized, drawing on such techniques as artificial intelligence, pattern recognition, digital signal processing, and statistical estimation. Moreover, recent advances in sensor technology and processing techniques, combined with improved hardware, make real-time fusion of data possible.

This special issue was aimed at exhibiting the latest research achievements, findings, and ideas in the integration of sensors in control and automation systems. The topics faced in this special issue were as follows: sensor systems for control and automation: sensors and sensor networks, intelligent sensors, sensor uncertainty for fault tolerant control, distributed and multimodality sensor network for control and automation, and so on; control: adaptive control, robust control, active disturbance rejection control, complex systems, identification and estimation, nonlinear systems, intelligent systems, sensor networks, delay systems, precision motion control, control applications, and so on; automation: man-machine interactions, process automation, network-based systems, intelligent automation, planning, scheduling and coordination, and so on; robotics: modelling and identification, mobile robotics, mobile sensor networks, perception systems, visual servoing, robot sensing and data fusion, and so on; process based control: sensor development, system design, and control development; control and automation systems: fault detection and isolation, sensing and data fusion, flight control and surveillance systems, rescue and field robotics, guidance control systems, industry, military, space and underwater applications, linear and nonlinear control systems, signal and image processing, and so on; industrial informatics: embedded systems for monitoring and controlling.

2.2 Answer the questions:

1) What is the role of a sensor in a control and automation system?

2) What are Industrial Control Systems (as defined in the text)?

3) Do you agree that there is much difference between sensor integration and sensor fusion?

4) What does the new wireless sensor technology facilitate?

5) What is the main disadvantage of running wires compared to wireless sensors (according to the text)?

2.3 Make up 5-7 questions of your own to the texts.

2.4 In the text, find terms definitions or Russian equivalents of which are given below:

1) Системы управления производственными процессами.

2) In the text…….. is defined as a device that converts a physical stimulus into a readable output.

3) Выходные данные в удобном для восприятия формате (text A, paragraph 2).

4) Простота развертывания и непосредственные преимущества.

5) I……devices have their own processing capability (text A, paragraph 4).

2.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Actuator; fixed-access; fusion; fault tolerant control; robust (control); robotics; nonlinear (control systems); to monitor; embedded (systems); facilitate; transformational; wireless (sensors); performance data; manufacturing; optimize; benefits; perception systems; installation (text B); wired devices; industrial.

2.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences with modal verbs and their equivalents (5-7).

2.7 Read text B and write a summary of it (not less than 7 sentences).

Text B. Wireless Sensor Technology

New wireless sensor technology facilitates unprecedented energy savings, waste reduction, and cost benefits. Creating a New Market New sensor technology developed with cost-shared funding from the Industrial Technologies Program (ITP) is immediately useful in a variety of industrial equipment and processes. Wireless sensors can be installed in places that were impractical for wired devices. The technology is proving as transformational for manufacturing as the Internet was for information distribution. Industry is just beginning to explore potential uses for industrial wireless technology.

Wireless system suppliers are finding that industry will purchase wireless systems because they make excellent business sense. The potential energy and cost benefits to the companies that use these systems—and to the nation—are impressive. Sample Application: Compressed Air Systems Sensors to monitor and optimize the performance of compressed air systems can help industrial facilities operate at peak efficiency. Until now, the high cost of running wires from sensors to a central monitoring station made this application impractical. Low-cost, wireless sensors were recently used in a paper mill to capture performance data in three compressors. The technology so impressed the mill management that it installed seven more wireless flow meters in less than a day. The ease of deployment and immediate benefits (documented energy savings of 30%) prompted the installation of five additional wireless sensors at key locations.

3 variant

3.1 Read texts A and B. Perform a written translation of text A.

Text A. Sensors

The purpose of sensors is to acquire information and to forward it in an evaluable format to the signal processing system. They are found in diverse tasks in technology, with different designs and operating principles. That is why it is important to categorize them. Sensors can be classified according to:

- operating principle (optical, inductive, mechanical, fluid, etc.),
- measured variable (displacement, pressure, distance, temperature, ph value, luminous intensity, presence of objects, etc.) or:
- output signal (analogue, digital, binary, etc.), to name just a few methods.

The sensors used most frequently in automation technology are those with digital outputs as they are much more immune to interference than those with analogue outputs. Digital controllers can also use the signals from these sensors directly without first having to convert them into digital signals by means of the so-called analogue-digital converters as is the case with analogue signals.

The sensors used most frequently in industrial automation are the so-called proximity sensors that determine the presence (or approach) of a workpiece.

Proximity Sensors.

We can say that proximity sensor is a device which detects objects nearby without any physical contact up to nominal range or sensor’s vicinity. We can also say in brief that sensors which convert information on the movement or presence of an object into an electrical signal are called proximity sensors.

Proximity sensors are non-contacting and therefore have no external mechanical actuating force. As a result they have a long service life and are very reliable.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.
The maximum distance that this sensor can detect is defined as "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Some know these processes as "thermosensation".

Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

Proximity sensors are commonly used on mobile devices to detect if someone is in nominal range. When the target is detected, the device lock screen UI will appear, thus emerging from what is known as sleep mode. Once the device has awoken from sleep mode, if the proximity sensor's target is still for an extended period of time, the sensor will then ignore it, and the device will eventually revert into sleep mode. For example, during a telephone call, proximity sensors play a role in detecting (and skipping) accidental touchscreen taps when held to the ear. They are also used in machine vibration monitoring to measure the variation in distance between a shaft and its support bearing. This is common in large team turbines, compressors, and motors that use sleeve-type bearings.

Types of Proximity Sensors.

A distinction is made between the following types of the proximity sensor:

1) *Sensors with mechanical switch contact* - Reed switches.

2) *Sensors with electronic switch output:*

- inductive proximity sensors;
- capacitive proximity sensors;
- optical proximity sensors.

When anything comes in the range of proximity sensor it flashes out infrared beams and monitors reflections. When the sensor senses reflections it confirms that there’s an object nearby.

Magnetic sensors.

Reed switches are magnetically-actuated proximity sensors. They consist of two contact blades in a small glass tube filled with protective gas. The action of a magnet causes the contact between the two blades to close so that an electrical current can flow. In the case of reed switches that work as N/C contacts, the contact blades are preloaded using small magnets. This preload is overcome by the then much stronger switching magnet.

Reed switches have a long service life and a short switching time (approx. 0.2 ms). They are maintenance-free, but must not be used in areas with strong magnetic fields (e.g. in the vicinity of resistance welders or CAT scanners).

Magnetic Proximity Sensors have no electrical noise effect and can work on DC, AC, AC/DC, DC. Sensing distance can vary due to such factors as temperature, the sensing object, surrounding objects, and the mounting distance between sensors. This type of sensors have highest sensing range up to 120 mm.

These sensors have been used in various devices like mobile phones, tablets, security appliances, etc. These days they are mostly used on mobile phones in order to make it more functional, responsive and useful.

Electronic sensors.

Electronic sensors include inductive, optical and capacitive proximity sensors. They generally have three electrical connections for:

- supply voltage;
- earth;
- output signal.

In the case of electronic sensors, no movable contact is switched over. Instead the output is either electrically connected with the supply voltage or to earth (= output voltage 0 V).

When it comes to the polarity of the output signal, there are two different designs of electronic proximity sensor:

1) In the case of positive-switching electronic sensors, the output has a voltage of zero (OFF) when there is no part within the sensor's response range. The approach of a workpiece results in the output being switched over (ON) so that supply voltage is applied.

2) In the case of negative-switching sensors, supply voltage is applied to the output when there is no part within the sensor's response range. The approach of a workpiece results in the output being switched over to a voltage of 0 V.

Inductive Proximity Sensors.

Inductive proximity sensors consist of an electrical resonant circuit, a flip-flop and an amplifier. When voltage is applied to the connections, the resonant circuit generates a (high-frequency) magnetic alternating field that escapes from the front side of the sensor. Bringing an electrical conductor into this alternating field "attenuates" the resonant circuit. The downstream electronic unit, consisting of a flip-flop and amplifier, evaluates the resonant circuit's behavior and actuates the output.

Inductive proximity sensors can be used to detect all materials with good electrical conductivity, for example graphite as well as metals.

The device generates an output signal or electrical signal when metal objects are either inside or entering into its sensing area from any direction. The metal objects above includes iron, aluminum, brass, copper, etc., with varied sensing distances.

The first inductive proximity sensor was introduced in the mid 60’s.

Capacitive Proximity Sensor.

Capacitive proximity sensors consist of an electrical resistor (R) and a capacitor (C) that together form an RC resonant circuit as well as an electronic circuit for evaluating the oscillation. An electrostatic field is generated between the active electrode and the ground electrode of the capacitor. A stray field forms on the front side of the sensor. When an object is brought into this stray field, the capacitance of the capacitor changes. The resonant circuit is attenuated and the downstream electronic unit actuates the output. Capacitive proximity sensors not only respond to materials with a high electrical conductivity (e.g. metals), but also to all insulators with a high dielectric constant (e.g. plastics, glass, ceramic, liquids and wood). It can also detect metals but along with it can also detect resins, liquids, powders, etc. The sensing distance can vary depending on covering material, cable longness, noise sensitivity. And it can also vary according to such factors as temperature, the sensing object, surrounding objects, and the mounting distance between sensors. Its maximum range of sensing is 25 mm.

Text B. Optical proximity sensors

Optical proximity sensors always have a transmitter and a receiver. They use optical (red or infrared light) and electronic components and modules to detect an object located between the transmitter and receiver. Particularly reliable transmitters of red and infrared light are semiconductor light emitting diodes (LEDs). They are small, robust, inexpensive, reliable, durable and easy to install. Red light has the advantage that it can be seen with the naked eye when aligning (adjusting) the optical axes of the proximity sensors.

Photodiodes or phototransistors are used as the receiver component in optical proximity sensors.

A distinction is made between three types of optical proximity sensor:

- through-beam sensors;
- retro-reflective sensors;
- diffuse sensors.

Through-beam sensors.

Through-beam sensors have transmitter and receiver units that are set apart. The components are mounted in such a way that the beam of light emitted by the transmitter hits the receiver (e.g. phototransistor) directly. If an object, workpiece or even a person enters the path between the transmitter and receiver, the light beam is interrupted and a signal is triggered that initiates a switching operation at the output (ON/OFF).

Retro-reflective sensors.

In retro-reflective sensors the transmitter and receiver are arranged side-by-side in a housing. The reflector reflects the light beam from the transmitter to the receiver. It is mounted in such a way that the light beam emitted by the transmitter impinges almost entirely on the receiver. If an object, workpiece or even a person enters the path between the transmitter and reflector, the light beam is interrupted and a signal triggered that initiates a switching operation at the output (ON/OFF).

Diffuse sensors.

The transmitter and receiver in diffuse sensors are arranged side-by-side in a component. In contrast to the retro-reflective sensor, a diffuse sensor does not have its own reflector. Instead it uses the reflective property of the object or workpiece that enters its transmission range. If the light hits a reflective body, it is redirected to the receiver and the sensor output is switched. This operational principle means diffuse sensors can only be used if the workpiece or machine part to be detected is highly reflective (e.g. metallic surfaces, light colors).

3.2 Answer the questions:

1) What is the purpose of sensors in a control and automation system?

2) What are the three types of optical proximity sensor?

3) What are the benefits of LEDs mentioned in the text?

4) Are inductive proximity sensors commonly used to detect dielectric materials?

5) Is it true that proximity sensors have no external mechanical actuating force? Why?

6) A diffuse sensor has its own reflector (true or false?).

3.3 Make up 5-7 questions of your own to the texts.

3.4 In the text, find terms definitions or Russian equivalents of which are given below:

1) Устройство, с помощью которого осуществляется преобразование цифрового кода в аналоговую величину.

2) R……s…….. are magnetically-actuated proximity sensors.

3) These days……….. are mostly used on mobile phones, tablets, security appliances, etc.

4) These sensors can respond both to conductors and insulators.

5) Лучевой датчик.

6) I……….. - electromagnetic radiation (EMR) with longer wavelengths than those of visible light.

3.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

To attenuate; oscillation; capacitance; reflective; proximity; diffuse; sensitivity; dielectric constant; to trigger; inductive; flip-flop; housing; electromagnetic; stray field; infra-red; electrostatic field; to actuate; phototransistor; optical axis; retro-reflective.

3.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

3.7 Write a summary of the text B "Optical proximity sensors" (not less than 7 sentences).

4 variant

4.1 Read text A and translate it.

Text A. Introduction to Control engineering

Engineering is concerned with understanding and controlling the materials and forces of nature for the benefit of humankind. Control system engineers are concerned with understanding and controlling segments of their environment, often called systems, to provide useful economic products for society. The twin goals of understanding and controlling are complementary because effective systems control requires that the systems should be understood and modeled. Furthermore, control engineering must often consider the control of poorly understood systems such as chemical process systems. The present challenge to control engineers is the modeling and control of modern, complex, interrelated systems such as traffic control systems, chemical processes, and robotic systems. Simultaneously, the engineer has the opportunity to control many useful and interesting industrial automation systems. Perhaps the most characteristic quality of control engineering is the opportunity to control machines and industrial and economic processes for the benefit of society.

Control engineering is based on the foundations of feedback theory and linear system analysis, and it integrates the concepts of network theory and communication theory. Therefore control engineering is not limited to any engineering discipline but is equally applicable to aeronautical, chemical, mechanical, environmental, civil, and electrical engineering. For example, a control system often includes electrical, mechanical, and chemical components. Furthermore, as the understanding of the dynamics of business, social and political systems increases, the ability to control these systems will also increase.

A control system is an interconnection of components forming a system configuration that will provide a desired system response. The basis for analysis of a system is the foundation provided by linear system theory, which assumes a cause–effect relationship for the components of a system. The input–output relationship represents the cause-and-effect relationship of the process, which in turn represents a processing of the input signal to provide an output signal variable, often with a power amplification. An open-loop control system utilizes a controller or control actuator to obtain the desired response. An open-loop system is a system without feedback. An open-loop control system utilizes an actuating device to control the process directly without using feedback control system. In contrast to an open-loop control system, a closed-loop control system utilizes an additional measure of the actual output to compare the actual output with the desired output response. The measure of the output is called the feedback signal. A feedback control system is a control system that tends to maintain a prescribed relationship of one system variable to another by comparing functions of these variables and using the difference as a means of control. A feedback control system often uses a function of a prescribed relationship between the output and reference input to control the process. Often the difference between the output of the process under control and the reference input is amplified and used to control the process so that the control of an industrial process (manufacturing, production, and so on) by automatic rather than manual means is often called automation. Automation is prevalent in the chemical, electric power, paper, automobile, and steel industries, among others. The concept of automation is central to our industrial society. Automatic machines are used to increase the production of a plant per worker in order to offset rising wages and inflationary costs. Thus industries are concerned with the productivity per worker of their plants. Productivity is defined as the ratio of physical output to physical input. In this case, we are referring to labor productivity, which is real output per hour of work. Furthermore, industry seeks to provide products that are increasingly precise, reliable, accurate, and robust. For example, precise, reliable control of automobile performance has improved markedly over the past decades.

Control systems are used to achieve (1) increased productivity and (2) improved performance of a device or system. Automation is used to improve productivity and obtain high-quality products. Automation is the automatic operation or control of a process, device, or system. We utilize automatic control of machines and processes to produce a product within specified tolerances and to achieve high precision.

4.2 Answer the questions:

1) Why are the “twin goals” of understanding and controlling are called “complementary” in the text?

2) “The present challenge to control engineers is the modeling and control of modern, complex, interrelated systems such as traffic control systems, chemical processes, and robotic systems”. Does it mean that these systems have not yet been properly understood?

3) According to the article, control engineering is only able to control machines and some social processes for the benefit of society (true or false?).

4) Control engineering integrates the concepts of *network theory* and *communication theory*. What other fundamental methods and theories are referred to in the text?

5) Do you agree with the author that the concept of automation is central to our industrial society?

6) What are the main goals of using automation and control systems?

4.3 Make up 5-7 questions of your own to the texts.

4.4 In the text, find terms definitions, the Russian equivalents of which are given below:

1) F…b…..h(s) = in order to help or be useful to the company or society.
2) C…e……….. = Техника автоматического управления.
3) C…e…..r = Причинно-следственная связь.
4) F……s…. = Сигнал обратной связи.
5) P………. is defined as the ratio of physical output to physical input.
6) A……….. can be defined as the technology by which a process or procedure is performed without human assistance.
7) Control systems engineers are c……… (deal with).

4.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Feedback; linear; open-loop; output signal variable; prevalent; labor productivity; (has improved) markedly; industrial society; (high) precision; performance; robotic system; a means of control; manufacturing; reference input; control actuator; inflationary costs; manual; accurate; benefit; specified tolerance.

4.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

4.7 Read text B "Open-loop system" and write a summary of it (not less than 7 sentences).

Text B. Open-loop System

The function of any electronic system is to regulate automatically the output and keep within the systems the desired input value or "set point". If the systems input changes for whatever reason, the output of the system must respond accordingly and change itself to reflect the new input value.

Likewise, if something happens to disturb the systems output without any change to the input value, the output must respond by returning back to its previous set value. In the past, electrical control systems were basically manual or what is called an *Open-loop System* with very few automatic control or feedback features built in to regulate the process variable so as to maintain the desired output level or value.

For example, an electric clothes dryer. Depending upon the amount of clothes or how wet they are, a user or operator would set a timer (controller) to say 30 minutes and at the end of the 30 minutes the drier will automatically stop and turn-off even if the clothes are still wet or damp.

In this case, the control action is the manual operator assessing the wetness of the clothes and setting the process (the drier) accordingly.

So in this example, the clothes dryer would be an open-loop system as it does not monitor or measure the condition of the output signal, which is the dryness of the clothes. Then the accuracy of the drying process, or success of drying the clothes will depend on the experience of the user (operator).

However, the user may adjust or fine tune the drying process of the system at any time by increasing or decreasing the timing controllers drying time, if they think that the original drying process will not be met. For example, increasing the timing controller to 40 minutes to extend the drying process.

5 variant

5.1 Read text A and translate it.

Text A. Principles and theory of automation

An automated system is designed to accomplish some useful action. Almost without exception, an automated system has three basic building blocks: (1) a source of power to perform some action, (2) feedback controls, and (3) machine programming.

There are many sources of power available, but the most commonly used power in today's automated systems is electricity. Electrical power is the most versatile, because it can be readily generated from other sources (e.g., fossil fuel, hydroelectric, solar, and nuclear) and it can be readily converted into other types of power (e.g., mechanical, hydraulic, and pneumatic) to perform useful work. In addition, electrical energy can be stored in high-performance, long-life batteries.

The actions performed by automated systems are generally of two types: (1) processing, (2) transfer and positioning. In the first case, energy is applied to accomplish some processing operation on some entity. The process may involve the shaping of metal, the molding of plastic, the switching of electrical signals in a communication system, or the processing of data in a computerized information system. All these actions entail the use of energy to transform the entity (e.g., the metal, plastic, electrical signals, or data) from one state or condition into another more valuable state or condition. The second type of action—transfer and positioning—is most readily seen in automated manufacturing systems designed to perform work on a product. In these cases, the product must generally be moved (transferred) from one location to another during the series of processing steps. At each processing location, accurate positioning of the product is generally required. In automated communications and information systems, the terms transfer and positioning refer to the movement of data (or electrical signals) among various processing units and the delivery of information to output terminals (printers, video display units, etc.) for interpretation and use by humans.

Feedback controls.

Feedback controls are widely used in modern automated systems. A feedback control system consists of five basic components: (1) input, (2) process being controlled, (3) output, (4) sensing elements, (5) controller and actuating devices. The term closed-loop feedback control is often used to describe this kind of system.

The input to the system is the reference value, or set point, for the system output. This represents the desired operating value of the output. Using the example of the heating system as an illustration, the input is the desired temperature setting for a room. The process being controlled is the heater (e.g., furnace). In other feedback systems, the process might be a manufacturing operation, the rocket engines on a space shuttle, the automobile engine in cruise control, or any of a variety of other processes to which power is applied. The output is the variable of the process that is being measured and compared to the input; in the above example, it is room temperature.

The sensing elements are the measuring devices used in the feedback loop to monitor the value of the output variable. In the heating system example, this function is normally accomplished using a bimetallic strip. This device consists of two metal strips joined along their lengths. The two metals possess different thermal expansion coefficients; thus, when the temperature of the strip is raised, it flexes in direct proportion to the temperature change. As such, the bimetallic strip is capable of measuring temperature. There are many different kinds of sensors used in feedback control systems for automation.

The purpose of the controller and actuating devices in the feedback system is to compare the measured output value with the reference input value and to reduce the difference between them. In general, the controller and actuator of the system are the mechanisms by which changes in the process are accomplished to influence the output variable. These mechanisms are usually designed specifically for the system and consist of devices such as motors, valves, solenoid switches, piston cylinders, gears, power screws, pulley systems, chain drives, and other mechanical and electrical components. The switch connected to the bimetallic strip of the thermostat is the controller and actuating device for the heating system. When the output (room temperature) is below the set point, the switch turns on the heater. When the temperature exceeds the set point, the heat is turned off.

5.2 Answer the questions:

1) Why is electric power considered to be the most versatile?

2) What are the basic types of actions completed by automated systems?

3) Is there any difference in the meaning of the term “transfer” when it is used in manufacturing and when it is referred to in communications? Comment.

4) What is the purpose of the controller and actuating devices in the feedback system?

5) What purpose(s) can a bimetallic strip be used for?

6) What functions do the controller and actuating devices in the feedback perform?

5.3 Make up 5-7 questions of your own to the texts.

5.4 In the text, find term definitions or Russian equivalents of which are given below:

1) To fulfil (paragraph 1, two words).
2) Universal (paragraph 2).
3) Source of energy, such as coal or oil.
4) Which of the following Russian terms corresponds to the meaning of the term “reference value” used in the text?
   - эталонное значение;
   - относительная величина;
   - опорная величина;
   - нормальное значение влияющей величины;
   - нормальное значение;
   - исходное значение.
5) Автоматическое регулирование в режиме замкнутого контура с обратной связью.
6) Коэффициент теплового расширения.
7) Подача информации к устройствам вывода.

5.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Feedback; controller; sensing element; closed-loop; variable; bimetallic; manufacturing; fossil fuel; to monitor; thermostat; switch; versatile; sensor; (direct) proportion; input; output; an actuating device; the set point; automated (systems); reference value; to flex.

5.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

5.7 Read text B “A Contactor” and write a summary of it (not less than 7 sentences).

Text B. A Contactor

A *contactor* is an electrically controlled switch (relay) used for switching an electrical power circuit. A contactor is typically controlled by a circuit which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 220-volt motor switch.

Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter (yard) on a side. Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.

A contactor has three components. The *contacts* are the current carrying part of the contactor. This includes power contacts, auxiliary contacts, and contact springs.

The *electromagnet* (or "*coil*") provides the driving force to close the contacts. The *enclosure* is a frame housing the contacts and the electromagnet. Enclosures are made of insulating materials such as Bakelite, Nylon 6, and thermosetting plastics to protect and insulate the contacts and to provide some measure of protection against personnel touching the contacts. Open-frame contactors may have a further enclosure to protect against dust, oil, explosion hazards and weather.

Magnetic blowouts use blowout coils to lengthen and move the electric arc. These are especially useful in DC power circuits. AC arcs have periods of low current, during which the arc can be extinguished with relative ease, but DC arcs have continuous high current, so blowing them out requires the arc to be stretched further than an AC arc of the same current. The magnetic blowouts in the pictured Albright contactor (which is designed for DC currents) more than double the current it can break, increasing it from 600 A to 1,500 A.

Sometimes an economizer circuit is also installed to reduce the power required to keep a contactor closed; an auxiliary contact reduces coil current after the contactor closes. A somewhat greater amount of power is required to initially close a contactor than is required to keep it closed. Such a circuit can save a substantial amount of power and allow the energized coil to stay cooler. Economizer circuits are nearly always applied on direct-current contactor coils and on large alternating current contactor coils.

A basic contactor will have a coil input (which may be driven by either an AC or DC supply depending on the contactor design). The coil may be energized at the same voltage as a motor the contactor is controlling, or may be separately controlled with a lower coil voltage better suited to control by programmable controllers and lower-voltage pilot devices. Certain contactors have series coils connected in the motor circuit; these are used, for example, for automatic acceleration control, where the next stage of resistance is not cut out until the motor current has dropped.

6 Variant

6.1 Read text A and translate it.

Text A. Manufacturing Applications of Automation and Robotics

One of the most important application areas for automation technology is manufacturing. To many people, automation means manufacturing automation. In this section, the types of automation are defined, and examples of automated systems used in manufacturing are described.

Three types of automation in production can be distinguished: (1) fixed automation, (2) programmable automation, and (3) flexible automation.

Fixed automation, also known as "hard automation," refers to an automated production facility in which the sequence of processing operations is fixed by the equipment configuration. In effect, the programmed commands are contained in the machines in the form of cams, gears, wiring, and other hardware that is not easily changed over from one product style to another. This form of automation is characterized by high initial investment and high production rates. It is therefore suitable for products that are made in large volumes. Examples of fixed automation include machining transfer lines found in the automotive industry, automatic assembly machines, and certain chemical processes.

Programmable automation is a form of automation for producing products in batches. The products are made in batch quantities ranging from several dozen to several thousand units at a time. For each new batch, the production equipment must be reprogrammed and changed over to accommodate the new product style. This reprogramming and changeover take time to accomplish, and there is a period of nonproductive time followed by a production run for each new batch. Production rates in programmable automation are generally lower than in fixed automation, because the equipment is designed to facilitate product changeover rather than for product specialization. A numerical-control machine tool is a good example of programmable automation. The program is coded in computer memory for each different product style, and the machine tool is controlled by the computer program. Industrial robots are another example.

Flexible automation is an extension of programmable automation. The disadvantage with programmable automation is the time required to reprogram and change over the production equipment for each batch of new product. This is lost production time, which is expensive. In flexible automation, the variety of products is sufficiently limited so that the changeover of the equipment can be done very quickly and automatically. The reprogramming of the equipment in flexible automation is done off-line; that is, the programming is accomplished at a computer terminal without using the production equipment itself. Accordingly, there is no need to group identical products into batches; instead, a mixture of different products can be produced one right after another.

Automated production lines.

An automated production line consists of a series of workstations connected by a transfer system to move parts between the stations. This is an example of fixed automation, since these lines are typically set up for long production runs (серийное производство), perhaps making millions of product units and running for several years between changeovers. Each station is designed to perform a specific processing operation, so that the part or product is constructed stepwise as it progresses along the line. A raw work part enters at one end of the line, proceeds through each workstation, and emerges at the other end as a completed product. In the normal operation of the line, there is a work part being processed at each station, so that many parts are being processed simultaneously and a finished part is produced with each cycle of the line. The various operations, part transfers, and other activities taking place on an automated transfer line must all be sequenced and coordinated properly for the line to operate efficiently. Modern automated lines are controlled by programmable logic controllers, which are special computers that facilitate connections with industrial equipment (such as automated production lines) and can perform the kinds of timing and sequencing functions required to operate such equipment.

Automated production lines are utilized in many industries, most notably automotive, where they are used for processes such as machining and press working. Machining is a manufacturing process in which metal is removed by a cutting or shaping tool, so that the remaining work part is the desired shape. Machinery and motor components are usually made by this process. In many cases, multiple operations are required to completely shape the part. If the part is mass-produced, an automated transfer line is often the most economical method of production. The many separate operations are divided among the workstations. Transfer lines date back to about 1924.

Press working operations involve the cutting and forming of parts from sheet metal. Examples of such parts include automobile body panels, outer shells of major appliances (e.g., laundry machines and ranges), and metal furniture (e.g., desks and file cabinets). More than one processing step is often required to complete a complicated part. Several presses are connected together in sequence by handling mechanisms that transfer the partially completed parts from one press to the next, thus creating an automated press working line.

6.2 Answer the questions:

1) In the article ‘hard automation’ is described as rather flexible, isn’t it?

2) What does an automated production line consists of?

3) What are modern automated lines controlled by?

4) What examples of programmable automation are given in the text?

5) For what processes are automated production lines generally used in automotive industry?

6.3 Make up 5-7 questions of your own to the texts.

6.4 In the text, find terms definitions or Russian equivalents of which are given below:

1) Производственное оборудование.
2) Серийный выпуск продукции (партиями).
3) Start-up capital.
4) A digital computer used for automation of industrial processes, such as control of machinery on factory assembly lines. …. are used to facilitate connections with industrial equipment.
5) Для перепрограммирования и замены оборудования требуется время…
6)…и происходит перерыв в производстве, после которого следует рабочий прогон каждой новой партии.

6.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Wiring; to accommodate; PLC; machining; to reprogram; a manufacturing process; workstation; an automated production line; automatic assembly machines; to facilitate; to sequence; function; to process; industrial equipment; flexible (automation); economical; off-line; computer terminal; multiple (operations); equipment.

6.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

6.7 Read text B "Contactors" and write a summary of it (not less than 7 sentences).

Text B. Contactors

A relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. A contactor is an electrically controlled switch used for switching a power circuit. A contactor is similar to a relay except higher current ratings. Contactors are used to control electric motors, lighting, heating, capacitor banks, and other electrical loads.

Basic Components of Contactor: A contactor has three components. The contacts are the current carrying part of the contactor. This includes power contacts, auxiliary contacts, and contact springs. The electromagnet provides the driving force to close the contacts. The enclosure is a frame housing the contact and the electromagnet.

A basic contactor has a coil input (which may be driven by either an AC or DC supply depending on the contactor design). The coil may be energized at the same voltage as the motor, or may be separately controlled with a lower coil voltage better suited to control by programmable controllers and lower-voltage pilot devices.

Operating Principle. Unlike general-purpose relays, contactors are designed to be directly connected to high-current load devices. Relays tend to be of lower capacity and are usually designed for both normally closed and normally open applications. Unlike relays, contactors are designed with features to control and suppress the arc produced when interrupting heavy motor currents. When current passes through the electromagnet, a magnetic field is produced, which attracts the moving core of the contactor. The electromagnet coil draws more current initially, until its inductance increases when the metal core enters the coil. The moving contact is propelled by the moving core; the force developed by the electromagnet holds the moving and fixed contacts together. When the contactor coil is de-energized, gravity or a spring returns the electromagnet core to its initial position and opens the contacts.

Main Contact. Main contacts of the contactor are normally open contact and are usually used to connect power load to the main supply.

Auxiliary Contacts. Auxiliary contacts are secondary switching devices which work in conjunction with primary switching equipment such as circuit breakers, relays, and contactors. These contacts are physically linked to the main switching mechanism and activate at the same time it does. Auxiliary contacts are commonly used as interlocks or retainers on the primary device's control circuit and are often used to give indication of its state of operation such as trip function indication, electrical interlocks, and start circuit retainers.

7 variant

7.1 Read text A and translate it.

Text A. Computer-integrated manufacturing

Since about 1970 there has been a growing trend in manufacturing firms toward the use of computers to perform many of the functions related to design and production. The technology associated with this trend is called CAD/CAM, for computer-aided design and computer-aided manufacturing. Today it is widely recognized that the scope of computer applications must extend beyond design and production to include the business functions of the firm. The name given to this more comprehensive use of computers is computer-integrated manufacturing (CIM).

CAD/CAM is based on the capability of a computer system to process, store, and display large amounts of data representing part and product specifications. For mechanical products, the data represent graphic models of the components; for electrical products, they represent circuit information; and so forth. CAD/CAM technology has been applied in many industries, including machined components, electronics products, and equipment design and fabrication for chemical processing. CAD/CAM involves not only the automation of the manufacturing operations but also the automation of elements in the entire design-and-manufacturing procedure.

Computer-aided design (CAD) makes use of computer systems to assist in the creation, modification, analysis, and optimization of a design. The designer, working with the CAD system rather than the traditional drafting board, creates the lines and surfaces that form the object (product, part, structure, etc.) and stores this model in the computer database. By invoking the appropriate CAD software, the designer can perform various analyses on the object, such as heat transfer calculations. The final object design is developed as adjustments are made on the basis of these analyses. Once the design procedure has been completed, the computer-aided design system can generate the detailed drawings required to make the object.

Computer-aided manufacturing (CAM) involves the use of computer systems to assist in the planning, control, and management of production operations. This is accomplished by either direct or indirect connections between the computer and production operations. In the case of the direct connection, the computer is used to monitor or control the processes in the factory. Computer process monitoring involves the collection of data from the factory, the analysis of the data, and the communication of process-performance results to plant management. These measures increase the efficiency of plant operations. Computer process control entails the use of the computer system to execute control actions to operate the plant automatically, as described above. Indirect connections between the computer system and the process involve applications in which the computer supports the production operations without actually monitoring or controlling them. These applications include planning and management functions that can be performed by the computer (or by humans working with the computer) more efficiently than by humans alone. Examples of these functions are planning the step-by-step processes for the product, part programming in numerical control, and scheduling the production operations in the factory.

Computer-integrated manufacturing includes all the engineering functions of CAD/CAM and the business functions of the firm as well. These business functions include order entry, cost accounting, employee time records and payroll, and customer billing. In an ideal CIM system, computer technology is applied to all the operational and information-processing functions of the company, from customer orders through design and production (CAD/CAM) to product shipment and customer service. The scope of the computer system includes all activities that are concerned with manufacturing. In many ways, CIM represents the highest level of automation in manufacturing.

Automation in Daily Life.

In addition to the manufacturing applications of automation technology, there have been significant achievements in such areas as communications, transportation, service industries, and consumer products. Some of the more significant applications are described in this section.

Communications.

One of the earliest practical applications of automation was in telephone switching. The first switching machines, invented near the end of the 19th century, were simple mechanical switches that were remotely controlled by the telephone user pushing buttons or turning a dial on the phone. Modern electronic telephone switching systems are based on highly sophisticated digital computers that perform functions such as monitoring thousands of telephone lines, determining which lines require service, storing the digits of each telephone number as it is being dialed, setting up the required connections, sending electrical signals to ring the receiver's phone, monitoring the call during its progress, and disconnecting the phone when the call is completed. These systems also are used to time and bill toll calls and to transmit billing information and other data relative to the business operations of the phone company. In addition to the various functions mentioned, the newest electronic systems automatically transfer calls to alternate numbers, call back the user when busy lines become free, and perform other customer services in response to dialed codes. These systems also perform function tests on their own operations, diagnose problems when they arise, and print out detailed instructions for repairs.

Other applications of automation in communications systems include local area networks, communications satellites, and automated mail-sorting machines. A local area network (LAN) operates like an automated telephone company within a single building or group of buildings. Local area networks are generally capable of transmitting not only voice but also digital data between terminals in the system. Communications satellites have become essential for communicating telephone or video signals across great distances. Such communications would not be possible without the automated guidance systems that place and retain the satellites in predetermined orbits. Automatic mail-sorting machines have been developed for use in many post offices throughout the world to read codes on envelopes and sort the envelopes according to destination.

7.2 Answer the questions:

1) What is "computer-integrated manufacturing (CIM)"? Explain.

2) Is there really a growing demand in "more comprehensive use of computers" nowadays? Respond.

3) What advantages of the computer system enable development of CAD/CAM technology?

4) What business functions is CIM system concerned with?

5) How can you evaluate the role of automated guidance system in the organization of satellite communications?

7.3 Make up 5-7 questions of your own to the texts.

7.4 In the text, find terms definitions or Russian equivalents of which are given below:

- автоматическая письмо-сортировочная машина;
- transportation and delivery of goods to the customer;
- определять длительность и стоимость дальних телефонных переговоров
- календарное планирование производственных операций;
- локальная сеть (ЛВС) работает как автоматическая телефонная компания в рамках одного здания или группы зданий;
- современные системы коммутируемой телефонной связи основаны на высокотехнологичных цифровых компьютерах.

7.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Billing; manufacturing; LAN; guidance system; predetermined; numerical control; product specifications; computer database; terminal (in the system); communicating (signals); remotely controlled (switches that were…); computer applications; function test(s); communications satellite(s); to store; switching; transfer (calls); to diagnose (problems); (product) shipment; toll calls.

7.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

7.7 Read text B "Transducer" and write a summary of it (not less than 7 sentences).

Text B. Transducer

A transducer is a device that converts energy from one form to another. Usually a transducer converts a signal in one form of energy to a signal in another.
Transducers are often employed at the boundaries of automation, measurement, and control systems, where electrical signals are converted to and from other physical quantities (energy, force, torque, light, motion, position, etc.). The process of converting one form of energy to another is known as transduction.

Transducer types.

Mechanical and electrical transducers.

Transducers that convert physical quantities into mechanical ones are called mechanical transducers; Transducers that convert physical quantities into electrical are called electrical transducers. EX: Bourdon's tube, which is used to measure pressure & LVDT (linear velocity transducer) used to measure displacement.

Sensors and actuators.

Transducers can be categorized by which direction information passes through them:

1) A *sensor* is a transducer that receives and responds to a signal or stimulus from a physical system. It produces a signal, which represents information about the system, which is used by some type of telemetry, information or control system.

2) *An actuator* is a device that is responsible for moving or controlling a mechanism or system. It is controlled by a signal from a control system or manual control. It is operated by a source of energy, which can be mechanical force, electrical current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. The control system can be simple (a fixed mechanical or electronic system), software-based (e.g. a printer driver, robot control system), a human, or any other input.

3) *Bidirectional transducers* convert physical phenomena to electrical signals and also convert electrical signals into physical phenomena. An example of an inherently bidirectional transducer is an antenna, which can convert radio waves (electromagnetic waves) into an electrical signal to be processed by a radio receiver, or translate an electrical signal from a transmitter into radio waves. Another example is voice coils, which are used in loudspeakers to translate an electrical audio signal into sound and in dynamic microphones to translate sound waves into an audio signal.

8 variant

8.1 Read text A and translate it.

Text A. Machine programming

The programmed instructions determine the set of actions that is to be accomplished automatically by the system. The program specifies what the automated system should do and how its various components must function in order to accomplish the desired result. The content of the program varies considerably from one system to the next. In relatively simple systems, the program consists of a limited number of well-defined actions that are performed continuously and repeatedly in the proper sequence with no deviation from one cycle to the next. In more complex systems, the number of commands could be quite large, and the level of detail in each command could be significantly greater. In relatively sophisticated systems, the program provides for the sequence of actions to be altered in response to variations in raw materials or other operating conditions.

Programming commands are related to feedback control in an automated system in that the program establishes the sequence of values for the inputs (set points) of the various feedback control loops that make up the automated system. A given programming command may specify the set point for the feedback loop, which in turn controls some action that the system is to accomplish. In effect, the purpose of the feedback loop is to verify that the programmed step has been carried out. For example, in a robot controller, the program might specify that the arm is to move to a designated position, and the feedback control system is used to verify that the move has been correctly made.

Some of the programmed commands may be executed in a simple open-loop fashion—i.e., without the need for a feedback loop to verify that the command has been properly carried out. For example, a command to flip an electrical switch may not require feedback. The need for feedback control in an automated system might arise when there are variations in the raw materials being fed into a production process, and the system must take these variations into consideration by making adjustments in its controlled actions. Without feedback, the system would be unable to exert sufficient control over the quality of the process output.

The programmed commands may be contained on mechanical devices (e.g., mechanical cams and linkages), punched paper tape, magnetic tape, magnetic disks, computer memory, or any of a variety of other media that have been developed over the years for particular applications. It is common today for automated equipment to use computer storage technology as the means for storing the programmed commands and converting them into controlled actions. One of the advantages of computer storage is that the program can be readily changed or improved. Altering a program that is contained on mechanical cams involves considerable work.

Programmable machines are often capable of making decisions during their operation. The decision-making capacity is contained in the control program in the form of logical instructions that govern the operation of such a system under varying circumstances. Under one set of circumstances, the system responds one way; under different circumstances, it responds in another way. There are several reasons for providing an automated system with decision-making capability, including (1) error detection and recovery, (2) safety monitoring, (3) interaction with humans, and (4) process optimization.

Error detection and recovery is concerned with decisions that must be made by the system in response to undesirable operating conditions. In the operation of any automated system, malfunctions and errors sometimes occur during the normal cycle of operations, for which some form of corrective action must be taken to restore the system. The usual response to a system malfunction has been to call for human assistance. There is a growing trend in automation and robotics to enable the system itself to sense these malfunctions and to correct for them in some manner without human intervention. This sensing and correction is referred to as error detection and recovery, and it requires that a decision-making capability be programmed into the system.

Safety monitoring is a special case of error detection and recovery in which the malfunction involves a safety hazard. Decisions are required when the automated system sensors detect that a safety condition has developed that would be hazardous to the equipment or humans in the vicinity of the equipment. The purpose of the safety-monitoring system is to detect the hazard and to take the most appropriate action to remove or reduce it. This may involve stopping the operation and alerting maintenance personnel to the condition, or it may involve a more complex set of actions to eliminate the safety problem.

Automated systems are usually required to interact with humans in some way. An automatic bank teller machine, for example, must receive instructions from customers and act accordingly. In some automated systems, a variety of different instructions from humans is possible, and the decision-making capability of the system must be quite sophisticated in order to deal with the array of possibilities.

A fourth reason for decision making in an automated system is to optimize the process. The need for optimization occurs most commonly in processes in which there is an economic performance criterion whose optimization is desirable. For example, minimizing cost is usually an important objective in manufacturing. The automated system might use adaptive control to receive appropriate sensor signals and other inputs and make decisions to drive the process toward the optimal state.

8.2 Answer the questions:

1) What are the programmed instructions intended for?

2) Any program consists of a certain number of unchangeable actions performed in the proper sequence, which cannot be altered until the program is completed (true or false?).

3) How (in what way) are programming commands related to feedback control in an automated system?

4) What is the purpose of the safety-monitoring system?

5) What measures can be taken in order to eliminate or reduce a safety problem?

8.3 Make up 5-7 questions of your own to the texts.

8.4 In the text, find terms definitions or Russian equivalents of which are given below:

1) A predetermined bunch of steps (operations) (paragraph 1).

2) Управление с обратной связью.

3) Банковский автомат (банкомат).

4) Критерий экономической производительности.

5) Continuous control for error detection in order to eliminate hazardous situations (s…..m……).

6) A branch of engineering and science dealing with design and use of robots.

8.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Adaptive control; to convert; safety hazard; open-loop; feedback control; malfunction; sensor; input; computer memory; an automated system; robotics; logical instructions; computer storage technology; automated equipment; to program; electrical switch; optimization; sensor signal; manufacturing; decision-making capacity.

8.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with modal verbs or their equivalents (5-7).

8.7 Read text B "Central Processing Unit -CPU" and write a summary of it (not less than 7 sentences).

Text B. Central Processing Unit – CPU

This unit is the most important unit in the building of a PLC, which is the "brain" of a PLC. In this unit lies a chip of microprocessor - an integrated circuit chip which controls the overall operation of the PLC control system.

Microprocessors contain arithmetic unit, control unit and a number of memory units, known as registrars. The main function of the microprocessor is to analyze data coming from field sensors through input modules, make decisions based on the user's defined control program and return signal back through output modules to the field output devices.

In detail, the CPU of a PLC does the following operations:

1) Updating inputs and outputs. This function allows a PLC to read the status of its input terminals and energize or deenergize its output terminals.

2) Performing logic and arithmetic operations. A CPU conducts all the mathematic and logic operations involved in a PLC.

3) Communicating with memory. The PLC programs and data are stored in memory. When a PLC is operating, its CPU may read or change the contents of memory locations.

4) Scanning application programs. An application program, which is called a ladder logic program, is a set of instructions written by a PLC programmer. The scanning function allows the PLC to execute the application program as specified by the programmer.

5) Communicating with a programming terminal. The CPU transfers program and data between itself and the programming terminal. Unit Memory is the component that stores information, programs and data in a PLC. The process of putting new information into a memory location is called writing. The process of retrieving information from a memory location is called reading.

CPU contains 2 types of memory: RAM and ROM.

1) RAM (Random Access Memory).

RAM is the memory type of read / write and is easy to program and repair. All users program are stored in this memory. Read indicates that the information stored in the memory can be retrieved or read, while write indicates that the user can program or write information into the memory. The data in the RAM would normally be lost if the power source is removed. This problem is solved by backing up the RAM with the battery.

2) ROM (Read Only Memory).

ROM is read-only memory type. Read Only indicates that the information stored in memory can be read only and cannot be changed. Information in ROM is placed there by the manufacturer for the internal use and operation of the PLC. The system program is stored in this memory. This program will not be lost when the power is disconnected. Special equipment is used to delete the program from this memory. The memory capacities of PLCs vary.

3) Display and Indicators.

Unit Display and the indicator unit refer to the internal relay PLC status display. This can be seen in the Console programming if the user uses the mnemonic code and programming computer screen or if the user uses software programming methods.

4) Input and Output Unit /Module.

The input and output units are the units available in the internal design of PLCs. The input/output units are the interfaces between the internal PLC systems and the external processes/ field devices to be monitored and controlled. Input Unit is the unit which input devices (switches, sensors) are connected to. While the output unit is a unit which output devices (Lights, motors) are connected to. The main purpose of the I/O interface is to condition the various signals received from or sent to the external input and output devices. Input modules convert signals from discrete or analog input devices to logic levels acceptable to PLC’s processor. Output modules convert signal from the processor to levels capable of driving the connected discrete or analog output devices. Since the PLC is a logic based device with a typical operating voltage of 5 volts and the external processes usually demand higher powers and currents, the I/O modules are optically or otherwise isolated. The typical I/O operating voltages are 5V - 240 V dc (or ac) and currents from 0.1A up to several amperes. The I/O modules are designed in this way to minimize or eliminate the need for any intermediate circuitry between the PLC and the process to be controlled. Small PLC units would have around 40 I/O connections with larger ones having more than 128 with either local or remote connections and extensive upgrade capabilities.

9 variant

9.1 Read text A and translate it.

Text A. Modern Control Practices

There are various cases in industrial control practice in which theoretical automatic control methods are not yet sufficiently advanced to design an automatic control system or completely to predict its effects. This situation is true of the very large, highly interconnected systems such as occur in many industrial plants. In this case, operations research, a mathematical technique for evaluating possible procedures in a given situation, can be of value.

In determining the actual physical control system to be installed in an industrial plant, the instrumentation or control-system engineer has a wide range of possible equipment and methods to use. He may choose to use a set of analogue-type instruments, those that use a continuously varying physical representation of the signal involved—*i.e.,* a current, a voltage, or an air pressure. Devices built to handle such signals, generally called conventional devices, are capable of receiving only one input signal and delivering one output correction. Hence they are usually considered single-loop systems, and the total control system is built up of a collection of such devices. Analogue-type computers are available that can consider several variables at once for more complex control functions. These are very specific in their applications, however, and thus are not commonly used.

The number of control devices added to an industrial plant may vary widely from plant to plant. They may comprise only a few instruments that are used mainly as indicators of plant-operating conditions. The operator is thus made aware of off-normal conditions and he himself manually adjusts such plant operational devices as valves and speed regulators to maintain control. On the other hand, there may be devices of sufficient quantity and complexity so that nearly all the possible occurrences may be covered by a control-system action ensuring automatic control of any foreseeable failure or upset and thus making possible unattended control of the process.

With the development of very reliable models in the late 1960s, digital computers quickly became popular elements of industrial-plant-control systems. Computers are applied to industrial control problems in three ways: for supervisory or optimizing control; direct digital control; and hierarchy control.

In supervisory or optimizing control the computer operates in an external or secondary capacity, changing the set points in the primary plant-control system either directly or through manual intervention. A chemical process, for example, may take place in a vat the temperature of which is thermostatically regulated. For various reasons, the supervisory control system might intervene to reset the thermostat to a different level. The task of supervisory control is thus to “trim” the plant operation, thereby lowering costs or increasing production. Though the overall potential for gain from supervisory control is sharply limited, a malfunction of the computer cannot adversely affect the plant.

In direct-digital control a single digital computer replaces a group of single-loop analogue controllers. Its greater computational ability makes the substitution possible and also permits the application of more complex advanced-control techniques.

Hierarchy control attempts to apply computers to all the plant-control situations simultaneously. As such, it requires the most advanced computers and most sophisticated automatic-control devices to integrate the plant operation at every level from top-management decision to the movement of a valve.

The advantage offered by the digital computer over the conventional control system described earlier, costs being equal, is that the computer can be programmed readily to carry out a wide variety of separate tasks. In addition, it is fairly easy to change the program so as to carry out a new or revised set of tasks should the nature of the process change or the previously proposed system prove to be inadequate for the proposed task. With digital computers, this can usually be done with no change to the physical equipment of the control system. For the conventional control case, some of the physical hardware apparatus of the control system must be replaced in order to achieve new functions or new implementations of them.

Control systems have become a major component of the automation of production lines in modern factories. Automation began in the late 1940s with the development of the transfer machine, a mechanical device for moving and positioning large objects on a production line (*e.g.*, partly finished automobile engine blocks). These early machines had no feedback control as described above. Instead, manual intervention was required for any final adjustment of position or other corrective action necessary. Because of their large size and cost, long production runs were necessary to justify the use of transfer machines.

The need to reduce the high labor content of manufactured goods, the requirement to handle much smaller production runs, the desire to gain increased accuracy of manufacture, combined with the need for sophisticated tests of the product during manufacture, have resulted in the recent development of computerized production monitors, testing devices, and feedback-controlled production robots. The programmability of the digital computer to handle a wide range of tasks along with the capability of rapid change to a new program has made it invaluable for these purposes. Similarly, the need to compensate for the effect of tool wear and other variations in automatic machining operations has required the institution of a feedback control of tool positioning and cutting rate in place of the formerly used direct mechanical motion. Again, the result is a more accurately finished final product with less chance for tool or manufacturing machine damage.

9.2 Answer the questions:

1) What kind of devices are generally called “conventional devices”?

2) How many input signals can conventional devices receive?

3) What, according to the article, can a mathematical technique be used for?

4) Control-system engineers do not make use of analogue-type instruments these days, as they are considered obsolete (true or false?).

5) For what reasons the programmability of the digital computer is called "invaluable" in the last paragraph? Can you comment on it?

6) "Its greater computational ability…" –What does the pronoun "its" stand for (paragraph 5)?

9.3 Make up 5-7 questions of your own to the text.

9.4 In the text, find terms definitions, or Russian equivalents, or initial letters of which are given below:

1) As it follows from the article, analogue-type instruments are generally called c…… devices and represent s….. - l….. systems. Is that correct? (Fill-in the missing letters).
2) A physical control system to be installed in an industrial plant can be estimated by an i…….. or c……..-s……engineer. (Fill-in the missing letters).
3) Hand (human) control (paragraphs 8-9).
4) Ability of the computer to be provided with a set of instructions.
5) An arrangement of machines in a factory where the products pass from machine to machine until they are finished (p….l…).
6) … с наименьшей вероятностью повреждения инструмента или производственного агрегата (станка).

9.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Instrumentation; malfunction; testing device; feedback control; variable; analogue-type; hardware apparatus; production monitor; thermostatically regulated; transfer machine; accuracy (of manufacture); computerized; manual intervention; secondary capacity; hierarchy control; set points; sophisticated (devices); computational (ability); to program (a computer); manufacturing; single-loop analogue controller.

9.6 1) In the text, find, write out and translate phrases (word combinations) where modal verbs or their equivalents are used (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

9.7 Read text B "Networks" and write a summary of it (not less than 7 sentences).

Text B. Networks

A network is the interconnection of a set of devices capable of communication. In this definition, a device can be a host (or an *end system* as it is sometimes called) such as a large computer, desktop, laptop, workstation, cellular phone, or security system. A device in this definition can also be a connecting device such as a router, which connects the network to other networks, a switch, which connects devices together, a modem (modulator-demodulator), which changes the form of data, and so on. These devices in a network are connected using wired or wireless transmission media such as cable or air. When we connect two computers at home using a plug-and-play router, we have created a network, although very small.

Network Criteria. A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security.

Performance.

Performance can be measured in many ways, including transit time and response time. Transit time is the amount of time required for a message to travel from one device to another. Response time is the elapsed time between an inquiry and a response. The performance of a network depends on a number of factors, including the number of users, the type of transmission medium, the capabilities of the connected hardware, and the type of transmission medium, the capabilities of the connected hardware, and the efficiency of the software.

Performance is often evaluated by two networking metrics: throughput and delay. We often need more throughput and less delay. However, these two criteria are often contradictory. If we try to send more data to the network, we may increase throughput but we increase the delay because of traffic congestion in the network.

Reliability.

In addition to accuracy of delivery, network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure, and the network's robustness in a catastrophe.

Security.

Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery from breaches and data losses.

10 variant

10.1 Read the text (A)"A Programming language" and perform its written translation.

Text A. A Programming language

A *programming language* is a formal language that specifies a set of instructions that can be used to produce various kinds of output. Programming languages generally consist of instructions for a computer. Programming languages can be used to create programs that implement specific algorithms.

The earliest known programmable machine that preceded the invention of the digital computer was the automatic flute player described in the 9th century by the brothers Musa in Baghdad, during the Islamic Golden Age. From the early 1800s, "programs" were used to direct the behavior of machines such as Jacquard looms and player pianos. Thousands of different programming languages have been created, mainly in the computer field, and many more still are being created every year. Many programming languages require computation to be specified in an imperative form (i.e., as a sequence of operations to perform) while other languages use other forms of program specification such as the declarative form (i.e. the desired result is specified, not how to achieve it).

The description of a programming language is usually split into the two components of syntax (form) and semantics (meaning). Some languages are defined by a specification document (for example, the C programming language is specified by an ISO Standard) while other languages (such as Perl) have a dominant implementation that is treated as a reference. Some languages have both, with the basic language defined by a standard and extensions taken from the dominant implementation being common.

Definitions.

A programming language is a notation for writing programs, which are specifications of a computation or algorithm. Some, but not all, authors restrict the term "programming language" to those languages that can express *all* possible algorithms. Traits often considered important for what constitutes a programming language include:

Function and target.

A *computer programming language* is a language used to write computer programs, which involves a computer performing some kind of computation or algorithm and possibly control external devices such as printers, disk drives, robots, and so on. For example, PostScript programs are frequently created by another program to control a computer printer or display. More generally, a programming language may describe computation on some, possibly abstract, machine. It is generally accepted that a complete specification for a programming language includes a description, possibly idealized, of a machine or processor for that language. In most practical contexts, a programming language involves a computer; consequently, programming languages are usually defined and studied this way. Programming languages differ from natural languages in that natural languages are only used for interaction between people, while programming languages also allow humans to communicate instructions to machines.

Abstractions.

Programming languages usually contain abstractions for defining and manipulating data structures or controlling the flow of execution. The practical necessity that a programming language support adequate abstractions is expressed by the abstraction principle; this principle is sometimes formulated as a recommendation to the programmer to make proper use of such abstractions.

Expressive power.

The theory of computation classifies languages by the computations they are capable of expressing. All Turing complete languages can implement the same set of algorithms. ANSI/ISO SQL-92 and Charity are examples of languages that are not Turing complete, yet often called programming languages.

Markup languages like XML or HTML which define structured data, are not usually considered programming languages. Programming languages may, however, share the syntax with markup languages if a computational semantics is defined. XSLT, for example, is a Turing complete XML dialect. Moreover, LaTeX, which is mostly used for structuring documents, also contains a Turing complete subset.

The term *computer language* is sometimes used interchangeably with programming language. However, the usage of both terms varies among authors, including the exact scope of each. One usage describes programming languages as a subset of computer languages. In this vein, languages used in computing that have a different goal than expressing computer programs are generically designated computer languages. For instance, markup languages are sometimes referred to as computer languages to emphasize that they are not meant to be used for programming.

Another usage regards programming languages as theoretical constructs for programming abstract machines, and computer languages as the subset thereof that runs on physical computers, which have finite hardware resources. John C. Reynolds emphasizes that formal specification languages are just as much programming languages as are the languages intended for execution. He also argues that textual and even graphical input formats that affect the behavior of a computer are programming languages, despite the fact they are commonly not Turing-complete, and remarks that ignorance of programming language concepts is the reason for many flaws in input formats.

10.2 Answer the questions:

1) What do programming languages generally consist of?

2) What are programming languages used for?

3) What, according to the article, is the basic difference between an imperative and a declarative forms of program specification?

4) By what principle are languages classified it the theory of computation?

5) According to the article, markup languages are sometimes referred to as computer languages, because they can also be used for programming. (true or false?).

10.3 Make up 5-7 questions of your own to the text.

10.4 In the text, find terms definitions or Russian equivalents of which are given below:

1) A process or set of rules to be followed in calculations or other problem-solving operations.

2) The linguistic and philosophical study of meaning, concerned with the relationship between signifiers (words, signs) and their denotation.

3) Two components of a programming language, mentioned in the article (form and meaning).

4) Язык описания технических требований.

5) Язык программирования – это язык, применяемый для написания компьютерных программ, предполагающих выполнение каких-либо вычислений или алгоритмов и, возможно, управление внешними устройствами вроде принтеров или дисководов.

10.5 Give definitions of the following lexical units, translate and show a relevant example of their use in the text:

Disc drive; markup language; abstraction principle; declarative (form of specification); graphical input format; syntax; semantics; reference; computer language; Turing complete; specification; HTML; imperative (form); generically designated (computer languages); computation; natural languages; structured data; ISO Standard; to communicate (instructions to machines).

10.6 1) In the text, find, write out and translate phrases (word combinations) where nouns are used as attributes (5-7).

2) Write out sentences or phrases with Passive Voice (5-7).

10.7 Read text B "Families of languages" and write a summary of it (not less than 7 sentences).

Text B. Families of Languages

There is a common misconception by people unfamiliar with computer programming that all programming languages are essentially the same. In one sense this is true because all digital electronic computers translate programming languages into strings of ones and zeros called binary, or Machine code.

While mainstream, personal computer languages tend to be derived from a specific tradition and are very similar (hence the popularity of this misconception), some languages fall into different paradigms which provide for a radically different programming experience. Programming in Java is quite different from programming in assembly language, which is quite different from programming in Haskell or Prolog or Forth, etc.

In the American Scientist article The Semicolon Wars, Brian Hayes classifies languages into four categories: imperative, object-oriented, functional, and declarative. Imperative and object-oriented languages tend to be used in the mainstream, whereas functional and declarative languages tend to be used in academic settings. Functional and declarative programming enthusiasts might argue that the paradigms are 20 years ahead of the mainstream and superior in many respects; however, mainstream language advocates would probably counter that such paradigms are hard to learn, or not very practical for their own unpopularity, among other things. We do not make any claims about who is right on this matter, but at the very least, we will suggest that building familiarity with the four major paradigms is an extremely valuable exercise.

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