ДЕЛОВОЙ ИНОСТРАННЫЙ ЯЗЫК

ПРИБОРОСТРОЕНИЕ. ПРИБОРЫ И СИСТЕМЫ ГОРНОГО И ТЕХНИЧЕСКОГО КОНТРОЛЯ

Методические указания к самостоятельным работам для студентов магистратуры направления 12.04.01

ENGLISH FOR SPECIFIC PURPOSES

GEOTECHNICAL INSTRUMENTATION AND ENGINEERING CONTROL SYSTEMS

САНКТ-ПЕТЕРБУРГ
2021

Министерство науки и высшего образования Российской Федерации
Федеральное государственное бюджетное образовательное
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Санкт-Петербургский горный университет

Кафедра иностранных языков

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ДЕЛОВОЙ ИНОСТРАННЫЙ ЯЗЫК. Приборостроение. приборы и системы горного и технического надзора и контроля: Материалы и методические указания для самостоятельной работы / Санкт-Петербургский горный университет. Сост. *И.С. Рогова, М.А. Троицкая.* СПб, 2021**.** 56 с.

Предназначены для самостоятельной работы студентов магистратуры направления подготовки 12.04.01 «Приборостроение. Приборы и системы горного и технического надзора и контроля» и согласованы с программой по иностранному языку для студентов неязыковых вузов. Изучение предложенного материала направлено на совершенствование навыков перевода текстов по специальности и формирование терминологического словарного запаса.

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ПРЕДИСЛОВИЕ

Данные методические указания по дисциплине "Деловой иностранный язык" предназначены для самостоятельной работы студентов магистратуры, обучающихся по направлению подготовки 12.04.01 «Приборостроение. Приборы и системы горного и технического надзора и контроля», а также могут быть полезны для студентов вузов технического профиля близких специальностей.

Предложенные аутентичные материалы и разработанный комплекс упражнений к ним направлены на совершенствование навыков устной и письменной иноязычной речи в ситуациях профессионально-ориентированного общения. Тематика текстов затрагивает различные виды оборудования, предназначенные для горного и технического надзора и контроля. Большая часть заданий нацелена на совершенствование навыков перевода, а также навыков ознакомительного и поискового чтения.

Особое внимание уделяется накоплению активного словарного запаса, который включает наиболее употребительные для специальности термины и слова общетехнического значения. Методические указания состоят из 2 разделов. Во втором разделе содержатся тексты для отработки навыка письменного перевода и пошаговое руководство к письменному переводу текстов с иностранного языка.

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UNIT I
Text 1
Introduction to Control Systems

I. Read and translate the following words and word combinations:
for the benefit of, to require, control system engineers, simultaneously, feedback theory, linear system analysis, traffic control systems, industrial automation systems, challenge, interrelated systems, electrical design
II. Find in the text a word that has the same or a similar meaning to the following:
to monitor, to deal with, double, objective, complicated, up-to-date, to connect, interrelated, basic principles, rapidly
III. Read and translate the following text.

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 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, robotic systems and industrial automation systems.

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.

A control systems engineer may specifically academically study and be qualified in control systems theories, industrial automation, mechatronics or robotics. Therefore to be a successful control systems engineer you need to understand and be familiar with more than one single discipline. There is a requirement to also know about electrical design, electronics, mechanical or mechatronics, computer science, process automation and physics. This does not mean you need to be an expert in every discipline.

The greatest skill a control systems engineer can develop is the ability to learn quickly what is important to learn in terms of technology. With so many options and products available, an individual or a company cannot be an expert in everything. The primary skill of a control systems engineer is to think outside the box, to know how components connect together, and how those components interface with the "real world" in real time.

It is common for a control system engineer to start out their career specialising in just one discipline. To be truly effective, they need to rapidly develop an appreciation for other disciplines. It may appear from this description that a control systems engineer is general in nature and a "jack of all trades". From a very high-level conceptual design perspective this remains true. However, with the amount of interfacing to other systems and areas of discipline, to know about just one of these disciplines makes it increasingly difficult for a single engineer to efficiently acquire all knowledge about the currently available hardware and software combinations to be effective. On top of this, systems engineers need to ensure a holistic, engineering approach to the design, development and deployment of a solution to ensure effective engineering practice and a safe application of the design and the technology.

IV. Underline all linking words and phrases in the text.

V. Answer the questions:

1.What does control engineering deal with?

2. What are the main components of a control system?

3.What skills does a control system engineer require? Why should he/she be a "jack of all trades"?

VI. Write a 100 (120) word short essay on the topic «The challenges of my future profession».

Text 2
From the History of Automatic Control

I. Read and translate the following words and word combinations:
feedback, float regulator, oil lamp, water-level mechanisms, temperature regulator, pressure regulator for steam boilers, pressure-cooker valve, flyball governor, steam engine, mechanical device, output shaft, flyweights, water-level float regulator, water inlet, oscillations, differential equation, frequency domain, electronic feedback amplifiers, airplane pilots, gun-positioning systems, radar antenna control systems
II. Complete the chart and translate the words:

Verb	Noun
to apply	
to maintain	
	invention
	regulator
to require	
	pressure
	development
to move	
to measure	
	performance
to amplify	
to construct	
	calculation

III. Find in the text a word that has the same or a similar meaning to the following words:
to monitor, objective, complicated, rate, precise, impact, outstanding, invention, technique, to happen, especially
IV. Read and translate the following text.

The use of feedback in order to control a system has had a fascinating history. The first applications of feedback control rest in the development of float regulator mechanisms in Greece in the period 300 to 1 B.C. The water clock of Ktesibios used a float regulator. An oil lamp

devised by Philon in approximately 250 B.C. used a float regulator for maintaining a constant level of fuel oil. Heron of Alexandria, who lived in the first century A.D., published a book entitled Pneumatica, which outlined several forms of water-level mechanisms ***using*** float regulators.

The first feedback system ***to be invented*** in modern Europe was the temperature regulator of Cornelis Drebbel (1572-1633) of Holland. Denis Papin (1647-1712) invented the first pressure regulator for steam boilers in 1681. Papin's pressure regulator was a form of safety regulator similar to a pressure-cooker valve.

The first automatic feedback controller ***used*** in an industrial process is generally agreed to be James Watt's flyball governor ***developed*** in 1769 for controlling the speed of a steam engine. (Fig.1)

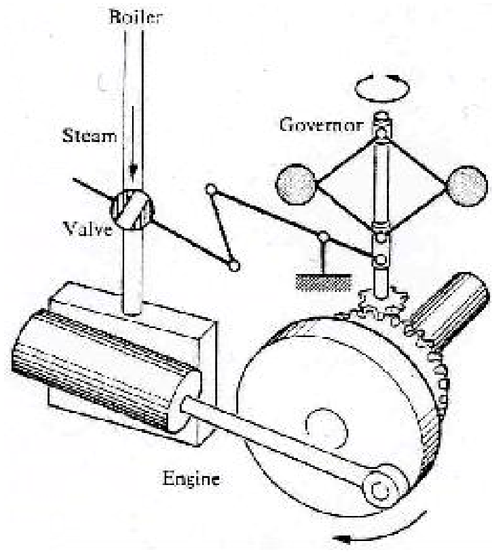

Fig. 1

The all-mechanical device measured the speed of the output shaft and utilized the movement of the flyball with speed to control the valve and therefore the amount of steam ***entering*** the engine. As the speed increases, the ball weights rise and move away from the shaft axis thus closing the valve. The flyweights require power from the engine in order to turn and therefore make the speed measurement less accurate.

The first historical feedback system claimed by Russia is the water-level float regulator said to have been invented by I. Polzunov in 1765. The float detects the water level and controls the valve that covers the water inlet in the boiler. (Fig. 2)

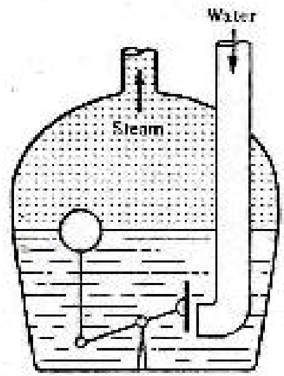

Fig. 2

The period preceding 1868 was characterized by the development of automatic control systems by intuitive invention. Efforts ***to increase*** an accuracy of the control system led to slower attenuation of the transient oscillations and even to unstable systems. It then became imperative to develop a theory of automatic control.

J. C. Maxwell formulated a mathematical theory related to control theory ***using*** a differential equation model of a governor. Maxwell's study was concerned with the effect various system parameters had on the system performance. During the same period, I.A. Vyshnegradskii formulated a mathematical theory of regulators.

Prior to World War II, control theory and practice developed in the United States of America and Western Europe in a different manner than in Russia and Eastern Europe. One main impetus for the use of feedback in the United States was the development of the telephone system and the electronic feedback amplifiers by Bode, Nyquist and the Bell Telephone Laboratories. The frequency domain was used primarily to describe the operation of the feedback amplifiers in terms of bandwidth and other frequency variables. In contrast, the eminent mathematicians and applied mechanicians in Russia inspired and dominated the field of control theory. Therefore, in Russian theory tended to utilize a time-domain formulation ***using*** differential equations.

A large impetus to the theory and practice of automatic control occurred during World War II when it became necessary to design and construct automatic airplane pilots, gun-positioning systems, radar antenna control systems, and other military systems based on the feedback control approach. The complexity and expected performance of these military systems necessitated an extension of the available control techniques and fostered interest in control systems and the development of new insights and methods. Prior to 1940, for most cases, the design of control systems was an art involving a trial-and-error approach. During the decade of the 1940s, mathematical and analytical methods increased in number and utility, and control engineering became an engineering discipline in its own right.

Frequency-domain techniques continued to dominate the field of control following World War II with the increased use of the Laplace transform and the complex frequency plane. During the 1950s, the emphasis in control engineering theory was on the development and use of the s-plane methods and, particularly, the root locus approach. Furthermore, during the 1980s, the utilization of digital computers for control components became routine. These new controlling elements possessed an ability to calculate rapidly and accurately that was formerly not available to the control engineer. There are now over ninety thousand digital process control computers ***installed*** in the United States. These computers are employed especially for process control systems in which many variables are measured and controlled simultaneously by the computer.

With the advent of Sputnik and the space age, another new impetus was imparted to control engineering. It became necessary to design complex, highly accurate control systems for missiles and space probes. Furthermore, the necessity to minimize the weight of satellites and to control them very accurately has spawned the important field of optimal control. Due to these requirements, the time-domain methods due to

Liapunov, Minorsky, and others have met with great interest in the last decade. New theories of optimal control have been developed by L.S. Pontryagin in Russia and R. Bellman in the United States. It now appears that control engineering must consider both the time-domain and the frequency domain approaches simultaneously in the analysis and design of control systems.

V. Answer the following questions:

1. Can you describe the first feedback control mechanism?
2. What was the first automatic feedback controller used in an industrial process?
3. Who was the inventor of the first feedback system in Russia?
4. What was Maxwell's study concerned with?
5. Why did control theory and practice develop faster in the United States of America and Western Europe than in Russia and Eastern Europe before World War II?
6. When did control engineering become a scientific discipline in its own right?
7. What did control engineering theory focus on during the 1950s?
8. When did the application of digital computers for control components become a common practice?
9. What is the main objective in the field of control engineering at the moment?

VI. Make a plan and give a short summary of the text.

VII. Pay your attention to the words in bold. Identify their part of speech and function in the sentence.

VIII. Complete the following sentences:

1. The float regulator mechanisms ***developed*** in ancient Greece were …
2. A book entitled Pneumatica ***published by*** Heron of Alexandria outlined…..
3. An oil lamp ***devised*** by Philon in approximately 250 B.C. used...
4. The first pressure regulator for steam boilers invented by D.Papin in 1681 was similar to….
5. The steam engine ***designed*** by James Watt's was supplied with ….

6. A mathematical model for a governor control of a steam engine ***formulated*** by J. C. Maxwell in 1868 became ….
7. Over ninety thousand digital process control computers ***installed*** in the United States are employed especially for…..
8. Mechanized assembly machines ***introduced by*** H.Ford were …..
9. Feedback amplifiers ***analysed by*** H.W. Bode….
10. A method for analyzing the stability of systems ***developed by*** H. Nyquist increased…..

Text 3
Control Systems

I. Read and translate the following text.
II. Answer the questions:
1. What is a control system?
2. What types of control systems do you know? What is the difference between them? Give some examples of both control system types.

Control systems are combinations of components (electrical, mechanical, thermal, or hydraulic) that act together to maintain actual system performance close to a desired set of performance specifications. Open- loop control systems (e.g., automatic toasters and alarm clocks) are those in which the output has no effect on the input (Fig. 3).

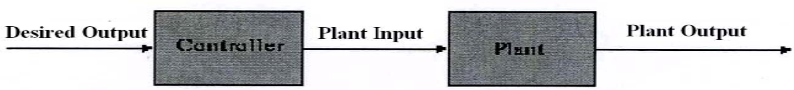

Fig. 3

Closed-loop control systems (e.g., thermostats, engine governors, automotive cruise-control systems, and automatic tuning control circuits) are those in which the output has an effect on the input in such a way as to maintain the desired output value (Fig. 4).

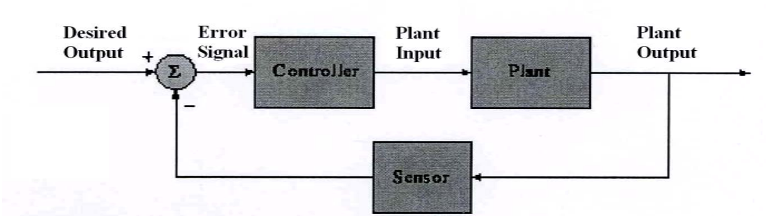

Fig. 4

A closed-loop system includes some way to measure its output to sense changes so that corrective action can be taken. The speed with which a simple closed-loop control system moves to correct its output is described by its damping ratio and natural frequency. A system with a small damping ratio is characterized by overshooting the desired output before settling down. Systems with larger damping ratios do not overshoot the desired output, but respond more slowly.

Text 4
Instrumentation and Process Control

I. Read and translate the following word combinations:

Instrumentation, industrial revolutions, to measure parameters, improvements in accuracy, waste reduction, domestic water heaters, variable temperature, interdependent variables, sensed signal, manufacturing process, advances in technology, measurement techniques

II. Find the words in the text that have the opposite meaning to the following words:

Up-to-date, industrial, slow, at separate times, degradation

III. Read and translate the following text.

Instrumentation and process control can be traced back many millennia. Some of the early examples ***are*** the process of making fire and instruments using the sun and stars, such as Stonehenge. The evolution of instrumentation and process control ***has undergone*** several industrial revolutions leading to the complexities of modern day microprocessor-controlled processing. Today's technological evolution has made it possible to measure parameters deemed impossible only a few years ago. Improvements in accuracy, tighter control, and waste reduction ***have*** also ***been achieved.*** Instrumentation and process control involve a wide range of technologies and sciences, and they ***are used*** in an unprecedented number of applications.

Instrumentation is the basis for process control in industry. However, it comes in many forms from domestic water heaters and HVAC, where the variable temperature ***is measured*** and used to control gas, oil, or electricity flow to the water heater, or heating system, or electricity to the compressor for refrigeration, to complex industrial process control applications such as used in the petroleum or chemical industry. In industrial control a wide number of variables, from temperature, flow, and pressure to time and distance, can be sensed simultaneously. All of these can be interdependent variables in a single process requiring complex microprocessor systems for total control.

Industrial instrumentation ***covers*** many aspects, such as sensing a wide range of variables, the transmission and recording of the sensed signal, controllers for signal evaluation, and the control of the manufacturing process for a quality and uniform product.

Due to the rapid advances in technology, instruments in use today may be obsolete tomorrow, as new and more efficient measurement techniques ***are*** constantly ***being introduced***. These changes ***are being driven*** by the need for higher accuracy, quality, precision, and performance. To measure parameters accurately, techniques ***have been developed*** that were thought impossible only a few years ago.

III. Answer the questions:

1. When did the history of instrumentation and process control start?
2. What achievements have been made in instrumentation and process control in the result of several industrial revolutions?
3. What is industrial process control based on?
4. What variables can be sensed simultaneously in industrial control?

IV. Identify the voice and tense of the verbs in bold.

V. Find an abbreviation in the text. What does it mean?

Text 5
Process Control

I. Match the following words and word combinations with their English equivalents.

1.	промышленный контроль	A	heat exchanger
2.	подача	B	process control loop
3.	теплообменник	C	actuator
4.	регулировать	D	supply
5.	выходная переменая	E	temperature sensor
6.	входная переменная	F	evaluate
7.	постояный	G	automobile engine
8.	датчик температуры	H	process control
9.	оценивать	I	input variable
10.	исполнительный механизм	G	adjust
11.	регулятор	K	constant
12.	автомобильный двигатель	L	controller
13.	устройство	M	output variable
14.	схема управления технологическим процессом	N	device

II. Five words (*thermometer, multivariables, controller, example, comparing*) have been removed from the text. Fill in the gaps with them.
III. Read and translate the following text.

In order to produce a product with consistently high quality, tight process control is necessary. A simple-to-understand (**1**)_______ of process control would be the supply of water to a number of cleaning stations, where the water temperature needs to be kept constant in spite of the demand. A simple control block is shown in Fig. 5: steam and cold water are fed into a heat exchanger, where heat from the steam is used to bring the cold water to the required working temperature. A (**2**)________ is used to measure the temperature of the water (the measured variable) from the process or exchanger. The temperature is observed by an operator who adjusts the flow of steam (the manipulated variable) into the heat exchanger to keep the water flowing from the heat exchanger at the constant set temperature. This operation is referred to as process control, and in practice would be automated as shown in Fig. 5. Process control is the automatic control of an output variable by sensing the amplitude of the output parameter from the process and **(3)**________ it to the desired or set level and feeding an error signal back to control an input variable—in this case steam.

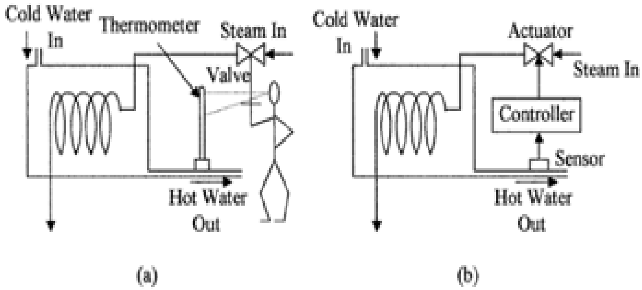

Fig. 5

A temperature sensor attached to the outlet pipe senses the temperature of the water flowing. As the demand for hot water increases or decreases, a change in the water temperature is sensed and converted to an electrical signal, amplified, and sent to a **(4)**________ that evaluates the signal and sends a correction signal to an actuator. The actuator adjusts the flow of steam to the heat exchanger to keep the temperature of the water at its predetermined value.

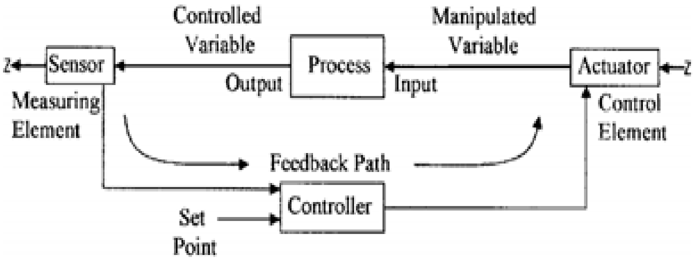

Fig. 6

Figure 6 shows the manual control of a simple heat exchanger process loop and automatic control of a heat exchanger process loop.

In any process there are a number of inputs, i.e., from chemicals to solid goods. These are manipulated in the process and a new chemical or component emerges at the output. The controlled inputs to the process and the measured output parameters from the process are called variables. In a process-control facility the controller is not necessarily limited to one variable, but can measure and control many variables. A good example of the measurement and control of (**5**) _______ that we encounter on a daily basis is given by the processor in the automobile engine. Figure 7 lists some of the functions performed by the engine processor. Most of the controlled variables are six or eight devices depending on the number of cylinders in the engine. The engine processor has to perform all these functions in approximately 5 ms. This example of engine control can be related to the operations carried out in a process-control operation.

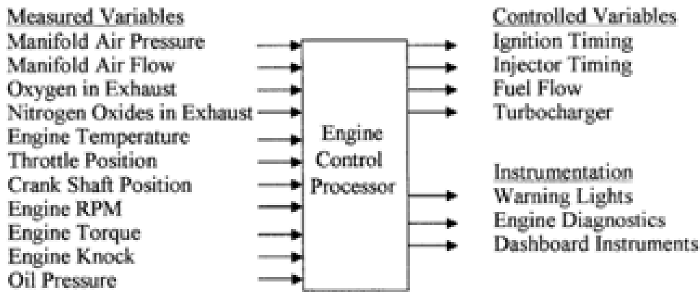

Fig. 7

IV. Make up 5 yes-no questions and 5 questions with a question word to the text.

Text 6
Geotechnical Instrumentation

I. Translate the following international words:
geotechnical, instrument, fundamental, component, engineer, engineering, monitoring, function, operation, project, maximum, distance, role, optimize, systematic, geology, materials, products, procedures.
II. Pay attention to the translation of the following "false friends":
safe, resolution, figure, affect, condition, accurate, data, design.
III. Pay attention to the translation of the following Latin terms:
etc. - *et cetera*, meaning "and others" or "and the rest" or "and so on."
(*All of the objects in our solar system (planets, comets,* ***etc.****) orbit the sun*).
e.g. - *exempli gratia*, meaning "for example"
(*Many cities (****e.g.****, New York, Miami and London) could face serious problems if the sea levels continue to rise*)
i.e. - *id est*, meaning "that is" or "that means" (*Europe's highest mountain (****i.e.****, Mt.Blanc) is in France*)
IV. Identify the Voice (Active/Pssive) of <u>the predicates</u> and translate them.
1. Its use **<u>extends</u>** from prefeasibility studies to mine closure.

2. …………. how instruments **can be deployed** and what they **are meant** to measure.
3. …………… **has led** to the development of …………
4. The engineer **must consider and balance** the job-related requirements.
5. It **is** usually **expressed** as …………….
6. ……………… to ensure that data accuracy and continuity **are maintained**.
7. Geotechnical instrumentation **plays** an important role in …….
8. It **must be recognized** that ……………….
9. Data **should** therefore **be measured and recorded** …………

V. Skim through the text = read quickly to get the general idea.

VI. Scan through the text (= read quickly to pick out particular information) and reorder the plan:

1. Data Measurement and Record
2. Use of Geotechnical Instrumentation
3. A Wide Variety of Devices
4. An Important Role in the Investigation
5. Choosing Instruments

VII. Read and translate the text.

Geotechnical instrumentation is a fundamental component of surface and underground mining engineering. Its use extends from prefeasibility studies to mine closure. Its purpose is multifold, serving both investigative and monitoring functions that are in part a necessity to ensure the economic feasibility of the mine operations and in part due diligence to ensure safe operations.

The required versatility in how instruments can be deployed (on surface, from boreholes, etc.) and what they are meant to measure (rock properties, ground movements, water pressures, etc.) has led to the development of a wide variety of devices. When choosing instruments for

a particular project, the engineer must consider and balance the job-related requirements of the following:

• **Range:** Range is the maximum distance over which the measurement can be performed, with greater range usually being obtained at the expense of resolution.
• **Resolution:** The resolution is the smallest numerical change an instrument can measure.
• **Accuracy:** The degree of correctness with respect to the true value is the accuracy, and it is usually expressed as a plus-or-minus number or as a percentage.
• **Precision:** Precision is the repeatability of similar measurements with respect to a mean, usually reflected in the number of significant figures quoted for a value.
• **Conformance:** Conformance is whether the presence of the instrument affects the value being measured.
• **Robustness:** This is the ability of an instrument to function properly under harsh conditions to ensure that data accuracy and continuity are maintained.
• **Reliability:** Reliability is synonymous with confidence in the data; poor quality or inaccurate data can be misleading and is worse than no data.

Geotechnical instrumentation plays an important role in the investigation of mine-site geology, geological structures (faults, jointing, etc.), rock mass properties, groundwater conditions, and in-situ stress fields. These are necessary inputs for carrying out prefeasibility studies and mine design, optimizing existing operations, and mitigating uncertainty in the mine design (but unfortunately not eliminating it). It must be recognized that rock and soil are natural earth materials, the products of many geological processes and complex interactions, and as such they are inherently variable.

Data should therefore be measured and recorded in systematic ways using standardized procedures.

VIII. Match the two halves of the table to get definitions:

1. Range	a) is the degree of correctness with respect to the true value is the accuracy, and it is usually expressed as a plus-or-minus number or as a percentage.
2. Resolution	b) is whether the presence of the instrument affects the value being measured.
3. Accuracy	c)is synonymous with confidence in the data; poor quality or inaccurate data can be misleading and is worse than no data.
4. Precision	d) is the smallest numerical change an instrument can measure.
5. Conformance	e)is the maximum distance over which the measurement can be performed, with greater range usually being obtained at the expense of resolution.
6. Robustness	f) is the repeatability of similar measurements with respect to a mean, usually reflected in the number of significant figures quoted for a value.
7. Reliability	g) is the ability of an instrument to function properly under harsh conditions to ensure that data accuracy and continuity are maintained.

IX. Answer the following questions:

1. What is geotechnical instrumentation used for?
2. What has led to the development of a wide variety of geotechnical devices?

3. How should the engineer choose instruments for a particular project?
4. Where does geotechnical instrumentation play an important role?
5. How should data be measured and recorded?

X. Give a short summary of the text.

Text 7

Integrated Mine Environment and Strata Condition Monitoring System

I. Translate the following word combinations:

mine accidents, roof and side falls, mine pillars, air blasts, haulage rope, continuous monitoring, strata conditions, ground support, ground failures, underground mine conditions, rock mass deformability, an integrated mine environment and strata condition monitoring system.

II. Pay attention to the translation of the following words and phrases:

as a consequence, with the help of, for a variety of reasons, thereby, keeping … in view, as well as.

III. Analyze the suffixes of the following terms and match the latter to the corresponding part of speech:

NOUNS:	ADJECTIVES:

explosion, environment, different, calibration, failure, environmental, healthy, continuous, assumption, haulage, equipment, humidity, preventive, effectiveness, miner, inundation, safety, suitable, pressure, stability, adjustment, additional, deformability.

IV. Identify the type of <u>Verbals</u> (Infinitive/Gerund/ Participle I/ Participle II), its function and translate the sentences.

1. Most of the accidents can be **<u>averted</u>** if regular **<u>monitoring</u>** of underground mine conditions is **<u>carried</u>** out with the help of suitable equipment.
2. **<u>Monitoring</u>** of environmental conditions is important in underground mines for **ensuring** the safety of miners.
3. **<u>To maintain</u>** a healthy environment inside underground mines, continuous **<u>monitoring</u>** of environmental is necessary.

4. ……………….. may be **carried** out for a variety of reasons, **including obtaining** data **needed** for mine design, thereby **allowing** calibration of computer models and adjustment of **mining** methods **to improve** stability.

5. **Keeping** these problems in view, an **integrated** mine environment and strata condition **monitoring** system ensures safety to mines.

V. Look at the title of the text and the key words to predict what the text is about.

Mine accidents, regular monitoring, environmental conditions, to ensure safety to mines, preventive measures.

VI. Skim through the text to check your ideas.

VII. Read and translate the text.

A lot of mine accidents occur during mining of coal and minerals, and as a consequence, thousands of miners die each year. Causes of accidents include roof and side falls, collapse of mine pillars, air blasts, and failure of haulage rope, electricity, mine fires, explosion, and inundation. Most of the accidents can be averted if regular monitoring of underground mine conditions is carried out with the help of suitable equipment.

Underground mines are categorized in three different areas: active working face, goaf, and sealed off areas. These areas require continuous monitoring of environmental parameters and strata conditions.

Monitoring of environmental conditions is important in underground mines for ensuring the safety of miners. To maintain a healthy environment inside underground mines, continuous monitoring of environmental parameters such as gas, pressure, coal dust, temperature, air velocity, and humidity levels is necessary.

Monitoring of strata conditions in mines may be carried out for a variety of reasons, including

(i) obtaining data needed for mine design, such as rock mass deformability or rock stresses;

(ii) verifying design data and assumptions, thereby allowing calibration of computer models and adjustment of mining methods to improve stability;

(iii) assessing the effectiveness of existing ground support and possibly directing the installation of additional support; and

(iv) warning of potential ground failures.

Keeping these problems in view, an integrated mine environment and strata condition monitoring system ensures safety to mines as well as miners by regular monitoring of the underground parameters and taking suitable preventive measures.

VIII. Answer the following questions:

1. What are the most common causes of mine accidents?
2. How can the accidents be averted?
3. How many different areas can underground mines be categorized in?
4. Why is monitoring of environmental conditions important?
5. What do we need to carry out monitoring of strata conditions for?

IX. Make a plan and give a short summary of the text.

Text 8
Slope Monitoring Systems

I. Translate the following word combinations:

early warning, continuous monitoring, dump slope, open-pit slope failure, ultimate failure, impending failure, pit wall failure, pit wall slope, slope instability, visual observation, basic instrumentation, slope monitoring techniques, slope monitoring program, remedial measures.

II. Pay attention to the translation of the following words and phrases:

in order to, a need for, in each case, therefore, previously, currently.

III. Complete the table with suitable words for each category (major types of word-formation)

Affixation		**Compound words**	**Acronyms**
Prefixes	**Suffixes**		

significant, deformation, probable , continuous, detection , time-domain, occurrence, *TDR,* open-pit, spontaneously, failure, dependent, movement, continuously, essential, previously, *LIDAR,* prediction, observation, instrumentation, microseismic, instability, movement, *GPS,* abnormal, suitable, remedial, currently, *SSR,* nonreflective, reflectometer digital, photogrammetry, global, high-resolution, .

IV. Look at the title of the text and the key words to predict what the text is about.

open-pit slope failure, the task of predicting, old and new slope monitoring techniques

V. Skim through the text to check your ideas.

VI. Scan through the text and find out what the following abbreviations stand for: *LIDAR, TDR, GPS, SSR.*

VII. Read and translate the text.

In order to detect significant changes in the degree of deformation and evaluate probable causes as well as consequences, there is a need for continuous monitoring of dump slope and providing early warning before occurrence of slope failure.

Open-pit slope failure does not occur spontaneously. It happens with prior signals in each case. But the task of predicting the exact failure is difficult, as the point of ultimate failure is dependent on a number of factors including rock type, slope height, slope angle, and presence of water. The best sign of impending failure is the increase in the rate of movement of pit wall slope. It is, therefore, essential to use this parameter as a tool for prediction of imminent pit wall failure.

Previously, slope monitoring techniques were practiced through visual observation and basic instrumentation. Some of the basic warning signs of slope instability are tension cracks, abnormal water flows, bulges or creep and rubble at the toe. The basic objectives of any slope monitoring program should be to detect deformation and prevent failure by taking suitable remedial measures.

Currently, new methods are emerging to monitor slope continuously. Some of the recent slope monitoring technologies are (i) automated total station networks (robots), (ii) nonreflective light detection and ranging (LIDAR) scanner, (iii) time-domain reflectometer (TDR), (iv) digital aerial photogrammetry, (v) global positioning system (GPS), (vi) high-resolution microseismic monitoring method, and (vii) slope stability radar (SSR).

VIII. Answer the following questions:

1. Is there a need for continuous monitoring of dump slope?
2. Why is the task of predicting the exact failure difficult?
3. What were previous slope monitoring techniques practiced through?
4. What are the basic objectives of any slope monitoring program?
5. What are some of the new methods of slope monitoring?

IX. Make a plan and give a short summary of the text.

Text 9
Gas Sensors for Underground Mines and Hazardous Areas

I. Translate the following word combinations:

underground coal mines, tough working conditions, hazardous environment, dangerously flammable gases, human beings, to take appropriate measures, untoward incidents, electrical response, to exceed the threshold concentration limit, power supply.

II. Pay attention to the translation of the following words and phrases:

be characterized by, due to, a rise in, such as, be essential for, be aimed at, within, in the form of,

III. Look at the title of the text and the key words to predict what the text is about.

hazardous environment, accidents, suitable sensors, detection of harmful gases, alarm, remedial actions

IV. Skim through the text to check your ideas.

V. Scan through the text and complete the sentences by matching the two halves of the table.

1. Many accidents occur ……………	***a)*** an alarm or activate other remedial actions.
2. Insufficient oxygen causes ……………	***b)*** employed to regularly monitor the levels of gases
3. Gas sensors are ………………	***c)*** early warning against explosive and toxic atmospheres.
4. The knowledge of these gases and their properties is	***d)*** death for mine workers.

………………	
5. The sensors are aimed at ………………	***e)*** the concentration of gas in the form of an electrical response.
6. These devices show ……………….	***f)*** due to a sudden rise in toxicants.
7. If the concentration exceeds the threshold concentration limit, these sensors give ……………..	***g)*** essential for development and selection of suitable sensors

VI. Read and translate the text.

Underground coal mines are characterized by tough working conditions and hazardous environment. Many accidents occur due to a sudden rise in toxicants such as carbon monoxide (CO) or dangerously flammable gases like methane (CH4) in mine air. Sometimes, insufficient oxygen causes death for mine workers.

To avoid such accidents, gas sensors are employed to regularly monitor the levels of gases like oxygen, methane, carbon dioxide, carbon monoxide, etc. The knowledge of these gases and their properties, as well as their physiological effects on human beings, is essential for development and selection of suitable sensors for the detection of harmful gases, as well as taking appropriate measures to avoid any untoward incidents.

The sensors are aimed at early warning against explosive and toxic atmospheres at places where miners normally work or travel. Gas sensors are used to detect the presence of various gases within an area. These devices show the concentration of gas in the form of an electrical response. If the concentration exceeds the threshold concentration limit, these sensors give an alarm or activate other remedial actions, such as increasing the ventilation, switching off the power supply, etc.

VII. Answer the following questions:

1. What are underground coal mines characterized by?
2. What can cause accidents in underground coal mines?

3. How can such accidents be avoided?

4. What is necessary for development and selection of suitable gas sensors?

5. When do gas sensors give an alarm or activate remedial actions?

VIII. Make a plan and give a short summary of the text.

Text 10
Characteristics of Gas Sensors

I. Translate the following word combinations:

recovery time, lower detection limit, dynamic range, detection point, lowest detection point, highest detection point, relative deviation, experimentally determined calibration graph, initial value, concentration value, step concentration change, maximum sensitivity, analyte concentration range, appropriate detectors, sampling techniques, reliable measurement, ambient conditions, impending hazard, target gases, easy maintenance, easy troubleshooting.

II. Pay attention to the translation of the following words and phrases:

in the presence of, for a certain period, be detected by, particularly, be required for, to respond to, be based on, depend on, adaptable to, and be backed by

III. Analyze the suffixes of the following terms and match the latter to the corresponding part of speech:

NOUNS:	ADJECTIVES:	ADVERBS

performance, essentially, various, sensitivity, lower, recovery, lowest, particularly, highest, experimentally, reliable, properly, physical, maintenance, quantity.

IV. Look at the title of the text and the key words to predict what the text is about.

performance of sensors, parameters, an ideal sensor, selection of sensors, maintenance

V. Skim through the text to check your ideas.

VI. Scan through the text and reorder the plan:

1. The Ideal Sensor
2. Selection of Sensors
3. Sensors Parameters

4.

VII. Match the two halves of the table to get definitions:

1. **Sensitivity** of a sensor	a) is the lowest concentration of the analyte that can be detected by the sensor under given conditions, particularly at a given temperature.
2. **Selectivity** of a sensor	b) is the time required for a sensor to respond to a step concentration change from zero to a certain concentration value.
3. **Stability** of a sensor	c) is its capacity to measure small changes in gas sensor.
4. **Lower detection limit**	d) is the smallest change it can detect in the quantity that it is measuring.
5. **Dynamic range**	e) is its ability to respond to a particular gas or a group of gases in the presence of various other gases.
6. **Linearity**	f) is its ability to retain its sensitivity, selectivity, and response, as well as recovery time for a certain period.
7. **Resolution**	g) is usually the temperature that corresponds to maximum sensitivity.
8. **Response time**	h) is the relative deviation of an experimentally determined calibration graph from an ideal

		straight line.
9. **Recovery time**	i)	is the period of time over which a sensor functions properly.
10. **Working temperature**	j)	is the concentration range of the analyte between the lowest detection point and the highest detection point.
11. **Hysteresis**	k)	is the time it takes for the sensor signal to return to its initial value after a step concentration change from a certain value to zero.
12. **Life cycle**	l)	is the maximum difference in output when the value is approached with an increasing and a decreasing analyte concentration range.

VIII. Read and translate the text.

Performance of sensors is characterized by the following parameters:

• **Sensitivity** of a sensor is its capacity to measure small changes in gas sensor.

• **Selectivity** of a sensor is its ability to respond to a particular gas or a group of gases in the presence of various other gases.

• **Stability** of a sensor is its ability to retain its sensitivity, selectivity, and response, as well as recovery time for a certain period.

• **Lower detection limit** is the lowest concentration of the analyte that can be detected by the sensor under given conditions, particularly at a given temperature.

• **Dynamic range** is the concentration range of the analyte between the lowest detection point and the highest detection point.

• **Linearity** is the relative deviation of an experimentally determined calibration graph from an ideal straight line.

• **Resolution** of a sensor is the smallest change it can detect in the quantity that it is measuring.

• **Response time** is the time required for a sensor to respond to a step concentration change from zero to a certain concentration value.

• **Recovery time** is the time it takes for the sensor signal to return to its initial value after a step concentration change from a certain value to zero.

• **Working temperature** is usually the temperature that corresponds to maximum sensitivity.

• **Hysteresis** is the maximum difference in output when the value is approached with an increasing and a decreasing analyte concentration range.

• **Life cycle** is the period of time over which a sensor functions properly.

An ideal sensor is one which possesses: (i) high sensitivity, dynamic range, selectivity, and stability; (ii) low detection limit; (iii) good linearity; (iv) small hysteresis and response time; and (v) long life cycle. However, no single gas sensor is found to show all these qualities. A combination of appropriate detectors and sampling techniques help in the reliable measurement of the target gas based on ambient conditions of the measuring area. The selection of the right sensor is important for mitigating the impending hazard.

Selection of sensors depends on various parameters, namely physical properties of target gases, ambient conditions, required sensitivity, maintenance cycle, method of operations, etc. Three qualities are essentially required in a sensor for gas monitoring, ie, simple, reliable, and easy maintenance. “Simple” means not too complicated, adaptable to user’s requirements and backed by strong technology. “Reliable” indicates the ability to raise an alarm at the right moment and never when it is not required. “Easy maintenance” specifies least requirement of calibration and easy troubleshooting.

IX. Answer the following questions:

1. What parameters characterize performance of sensors?
2. Can any single sensor show all the qualities of an ideal sensor?
3. What is the selection of the right sensor important for?
4. What does selection of sensors depend on?
5. How many qualities are essentially required in a sensor for gas monitoring?

X. Give a short summary of the text.

Text 11
Mine Transport Surveillance and Production Management System

I. Translate the following word combinations:
integral part, mineral resources, unauthorized mining, vehicle overloading, poor transparencies, equipment optimization, production scheduling, idling of shovels and dumpers, open-cast mines, obvious consequence, suitable solutions, inductive loop detectors, video image processors, infrared sensors, ultrasonic sensors, passive acoustic arrays, global positioning system, video vehicle surveillance, mine transport surveillance and production management system, weighbridge automation module, accurate measurement, vehicle tracking and production monitoring module, transportation route, closed-circuit television camera, periphery surveillance module, illegal transportation, centralized monitoring station, equipment scheduling techniques, overall mine design, substantial costs, owned resources .

II. Pay attention to the translation of the following words and phrases:
be endowed with, lack of, thereby, throughout, make it easy to, be important for, be associated with,

III. Analyze the formation of the following words:
unauthorized, overloading, improper, weighbridge, illegal, inconsistency.

IV. Match the two halves of the phrases:

1. to form	**a)** to these problems
2. major causes	**b)** of different modules
3. suitable solutions	**c)** for the development
4. to consist	**d)** unauthorized access
5. requirements	**e)** to the fullest

6.	to help	**f)**	an integral part
7.	to prevent	**g)**	maximize profit
8.	to utilize time and resources	**h)**	of concern

V. Look at the title of the text and the key words to predict what the text is about.

unauthorized mining, vehicle overloading, poor transparencies, lack of equipment optimization, improper production scheduling, suitable solutions, the mine transport surveillance and production management system, productivity and effectiveness

VI. Skim through the text to check your ideas.
VII. Scan through the text and find out how many modules the mine transport surveillance and production management system consists of.
VIII. Read and translate the text.

Mining activities form an integral part in the economic development of any country endowed with mineral resources. Unauthorized mining, vehicle overloading, poor transparencies during mineral transportation, lack of equipment optimization and improper production scheduling, and idling of shovels and dumpers are some of the major causes of concern in open-cast mines. As an obvious consequence of searching suitable solutions to these problems, recent decades have witnessed wide application of communication, sensing, surveillance, and vehicle detection technologies.

Various types of sensors are now used for detection and surveillance of vehicles, some of which are inductive loop detectors, video image processors, infrared (IR) sensors, ultrasonic sensors, passive acoustic arrays, global positioning system (GPS), and video vehicle surveillance.

The mine transport surveillance and production management system consists of different modules. These include:

(i) a weighbridge automation module for accurate measurement of minerals and thereby checking mineral overloading;

(ii) vehicle tracking and production monitoring module for tracking mine vehicles throughout their transportation route and monitoring production;

(iii) closed-circuit television camera for surveillance of the surrounding, including transport system in mines;

(iv) periphery surveillance module for detecting the intrusion of vehicles with its intention of illegal transportation of minerals through unauthorized routes; and

(v) a centralized monitoring station for supervising all the activities of transport surveillance, as well as production monitoring from a central location.

The system also includes production monitoring and equipment scheduling techniques that provide projections of future mining progress and time requirements for the development and extraction of a resource. The visualization of the production makes it easy to detect inconsistencies and also to make improvements to the allocation of resources in mines. Production management is important for overall mine design because of the substantial costs associated with labor, supplies and equipment, which are affected by production scheduling. The use of the monitoring system increases productivity and effectiveness in communication of information. Better production management helps to maximize profit and determine future investments, as well as conserve and develop owned resources. Therefore, it is proposed to install a system to prevent unauthorized access, track and monitor vehicles location and utilize time and resources to the fullest.

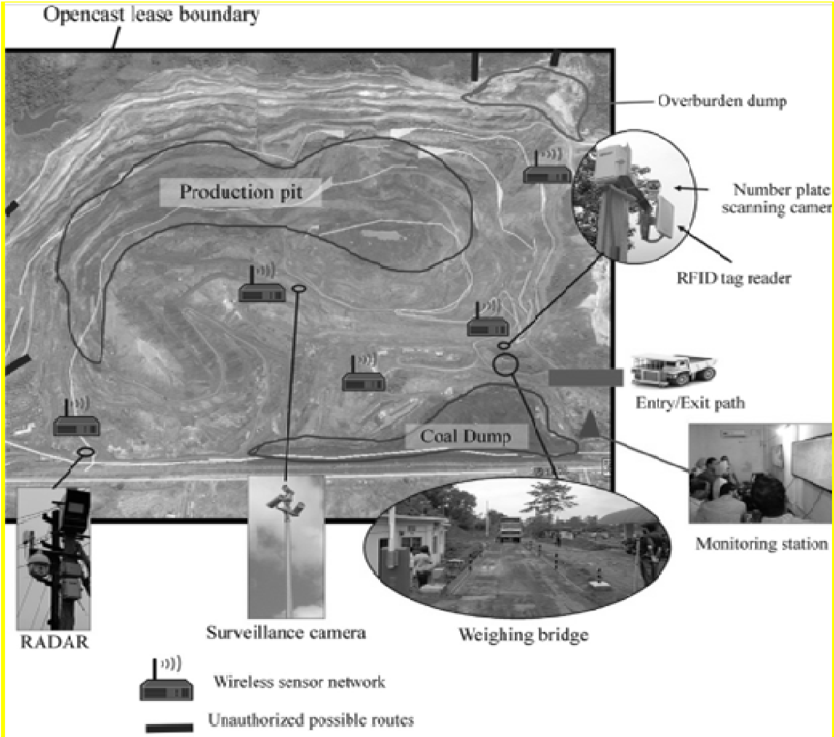

Fig. 8. Mine transport tracking and surveillance system.

IX. Answer the following questions:

1. What are major causes of concern in open-cast mines?
2. What is a consequence of searching suitable solutions to these problems?
3. How many different modules does the mine transport surveillance and production management system consists of?
4. What do production monitoring and equipment scheduling techniques provide?
5. Why is it proposed to install such a system in mines?

X. Make up a plan and give a short summary of the text.

Text 12
A Digital Mine

I. Translate the following word combinations:
real-time monitoring, mine-inclusive machinery, data management, production management, electrical facilities, collaborative decision environment, value chain, meaningful information, time-based approach, shearer position, shield heights, standstill monitoring, load-haul-dump machine, mining assets, event-driven video control, transparent management.

II. Pay attention to the translation of the following words and phrases:
be based on, be applied for, as well as, be divided into, in essence, focus on, on the basis of, and so on, as a result of, advantages of, provide information about,

III. Look at the title of the text and the key words to predict what the text is about.
digital mines, Internet of Things, an integrated view of the mine plan and operations, safe and comfortable working environment

IV. Skim through the text to check your ideas.

***V. Scan through the text and find out* what the following abbreviations stand for:** *IoT, CCTV, 3D, RFID.*

VI. Complete the sentences with the missing words:

simulation, information, value, probability, management, visualization

1. A digital mine is a ____________ of mine-inclusive machinery and equipment, as well as the production process.
2. A digital mine provides ___________ about different faces of mines, roadways, mine mechanics, electrical facilities, mine ventilation, safety, environmental conditions, and so on.
3. Mine management seeks to add __________ by converting data into meaningful information.
4. Digital mine technology helps to deploy collected information for estimating the failure _________ of specific components.

5. IoT-based digital mining can be used for ___________ of information related to geological conditions, mining operations, hazard, mines environment, mines safety, etc.
6. A digital mine has three-dimensional (3D) __________, 3D spatial interpolation and 3D spatial data analysis features.

VII. Read and translate the text.

Digital mines based on the Internet of things (IoT) are applied for real-time monitoring and viewing of mining information to increase production of coal or minerals and minimize accidents in underground mines.

A digital mine is a virtual expression of an actual mine. It is a simulation of mine-inclusive machinery and equipment, as well as the production process. People can query and interact with the virtual body. A digital mine is divided into two layers in essence:

The first layer digitizes inherent mine information to comprehensively and exhaustively depict mines and ore bodies according to 3D coordinates.

On the basis of the first layer, all the relevant information are inserted to form a more significant and multidimensional digital mine.

Basic advantages of a digital mine are continuous and consistent data management, production management and consequent introduction of engineering methods and tools. A digital mine provides information about different faces of mines, roadways, mine mechanics, electrical facilities, mine ventilation, safety, environmental conditions, and so on. It helps increase focus on miners' safety and mine productivity.

Digital solutions include creation of a "collaborative decision environment," a facility that enables an integrated view of the mine plan and operations, leading to early identification and rectification of any bottlenecks across the value chain. Mine management seeks to add value by converting data into meaningful information and to increase productivity by automating the actions required as a result of meaningful information.

Digital mine technology helps to deploy collected information for estimating the failure probability of specific components rather than using a traditional time-based approach that reduces maintenance cost and prevents unplanned interruptions.

IoT-based digital mining can be used for information retrieval and management of information related to geological conditions, mining operations, hazard, mines environment, mines safety, etc.

A digital mine helps to control and manage:

- all equipment in underground mine;
- mine face and strata visualization, including diagrams showing the percentage of mineral/stone in production, shearer position, shield heights, and pressure on shields;
- infrastructure monitoring including electrical network, water drainage, air pressure, etc.;
- conveyors/belts/bunker/transportation equipment;
- standstill monitoring for machinery and transportation equipment including conveyors, shearer, ploughs, load-haul-dump machine, etc.;
- mapping of mining assets position against geographical map for observation, supply, and maintenance operation;
- miners/transportation tracking;
- ventilation and production;
- mine hazards and safety; and video integration (CCTV), event-driven video control for operators' support.

A digital mine has three-dimensional (3D) visualization, 3D spatial interpolation and 3D spatial data analysis features. It helps create a safe and comfortable working environment. It makes for transparent management of surface and underground objects at all times and in all mining areas.

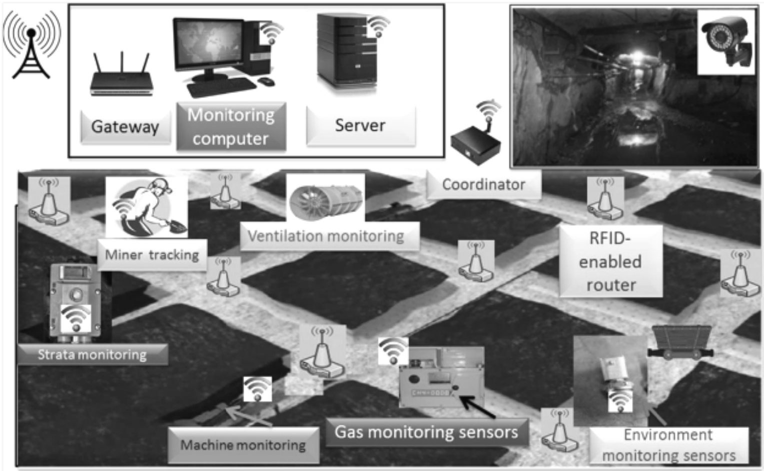

Fig. 9. Deployment of wireless network and IoT enabled devices in underground mine.

The devices that are deployed for digital mining include different sensors, RFID devices, CCTV, power supply, gateway, server, 3D display unit, audio-visual warning system, etc..

VIII. Answer the following questions:

1. What are digital mines based on the Internet of things (IoT) applied for?
2. What is a a digital mine?
3. How many layers can a digital mine be divided into?
4. What are basic advantages of a digital mine?
5. How can mine management add value?
6. What does a digital mine help to control and manage?
7. What devices are deployed for digital mining?

IX. Make up a plan and give a short summary of the text.

UNIT II

TECHNICAL TRANSLATION PRACTICE

Перевод иностранного текста

При переводе англоязычной технической литературы необходимо помнить, что в английском языке предложения имеют **фиксированный порядок слов**, где каждый член предложения занимает определенное место, которое принято обозначать следующим образом:

I Подлежащее или группа подлежащего (подлежащее с поясняющими словами) не имеет перед собой предлога и чаще всего занимает в предложении первое место.

II Сказуемое занимает второе место и начинается с личной формы глагола. Сказуемые бывают глагольными и именными.

III Прямое дополнение или группа прямого дополнения (дополнение с поясняющими словами) располагается после сказуемого и употребляется без предлога.

IV Предложное дополнение или группа предложного дополнения стоит после сказуемого или после прямого дополнения и употребляется с предлогом.

IV* Обстоятельство или группа обстоятельства, следующее за дополнением, а при отсутствии дополнения – за сказуемым.

О Обстоятельство (места, времени, цели, причины, образа действия), которое стоит перед подлежащим в начале предложения.

л.о. Левое определение.

п.о. Правое определение.

Проанализируйте следующие примеры:

1.|**I** Electronics | **II** has made| **III** great progress| **IV*** in the last twenty years|.

Электроника добилась значительных успехов за последние двадцать лет.

2. | **I** This л.о. flight report| **II** will be published| **IV** in the next article|. *Отчет об этом полете будет опубликован в следующей статье.*

3. |**O** In the second half of the last century|**I** mankind| **II** changed| **III** understanding of family values| **IV** drastically|.

Во второй половине прошлого века человечество изменило представление о семейных ценностях кардинальным образом.

Пошаговое руководство к письменному переводу текстов с иностранного языка

1. Просмотрите текст (статью, главу) до конца, выявите его направленность и соотнесите содержание с заголовком. Определите, с какой областью связаны значения слов и/или терминов; это поможет выбрать нужный эквивалент незнакомого слова при пользовании словарем.
2. Найдите в тексте незнакомые слова и определите, какой частью речи они являются, обращая внимание на суффиксы и префиксы. Не следует выписывать незнакомые слова сразу из всего текста и переводить их изолированно. Этот способ не оправдывает себя: во-первых, о значении некоторых слов можно догадаться, переведя предыдущую часть текста; во-вторых, придется выписывать либо все значения многозначного слова, либо первое попавшееся, которое может и не подойти для данного предложения, и тогда нужно будет снова обращаться к словарю, отыскивая другое, подходящее значение слова по контексту.
3. Начинайте переводить отдельные предложения. Вначале следует определить, является ли предложение простым (содержит одну основу – подлежащее и сказуемое) или сложным (содержит более одной основы). Если предложение сложное, разделите его на отдельные предложения, выявив сложносочиненный или сложноподчиненный тип связи. В сложносочиненных предложениях простые предложения разделены союзами and, or, but и др.; в составе сложноподчиненных предложений на стыке главного и придаточного располагаются союзы и союзные слова that, whether,

if; вопросительные слова which, where, when и др. Каждое простое предложение в составе сложного следует переводить отдельно.

4. В простом предложении найдите группу сказуемого, ориентируясь на личную форму глагола (суффиксы –s, -ed, глаголы is, are, was, were,will, has, have, had и др.).

5. Справа от группы сказуемого найдите группу подлежащего (существительное/местоимение с определениями или без них), справа от сказуемого располагается группа дополнения и/или обстоятельства. Проверьте предложение на наличие неличных форм (инфинитива, герундия, причастий) и оборотов с ними.

6. Переведите предложение в следующем порядке: (группа обстоятельства), группа подлежащего, группа сказуемого, группа дополнения, группа обстоятельства). Заметьте, что группа обстоятельства может располагаться как в начале предложения, так и в его конце.

7. Записывайте перевод, проверяя соответствие каждой фразы оригиналу.

8. Без обращения к иностранному тексту отредактируйте свой перевод. т. е. проверьте, насколько четко и ясно передана мысль автора, соответствует ли ее изложение нормам русского языка. Постарайтесь заменить несвойственные русскому языку выражения и обороты синонимичными языковыми средствами.

Text 1
Automated Total Station Networks

In mines, a number of robotic total stations, also known as the automated total stations, are installed. The number is dictated by range, atmospheric conditions, visibility, design of the optics, power of laser, and resolution of charge coupled device camera. These total stations are usually placed at the top of a pit to identify visibility of as many targets as possible. At least one stable station is required for accounting of rotation orientation. This is obtained by using a network of total stations to a common prism. The total stations can also be linked to satellite-based positioning systems that provide absolute control. These are housed in special casings to protect them from blasting and adverse site weather conditions.

A number of prisms are installed on a slope at a regular spacing for measuring its movements (Fig. 1.8). The customized software provides a total integration using wireless communication network to measure movements of slopes in X, Y, and Z directions. A vector plot combining the above three movements into absolute movement is obtained. These data are recorded in either real time or post-processed mode. Alarms are set at site-specific trigger levels for early identification of slope movements.

The major advantages in prism monitoring system are increased precision of the coordinates, continuous measurement in all weather conditions, and accurate measurement with a distant reference point. On the other hand, the disadvantage is that it requires an open-sky view; otherwise, the system will be affected by insufficient tracked satellites. It can also be affected by adjacent machinery which hinders proper functioning of the system.

1513 печатных знаков без пробелов

Text 2
Nonreflective Lidar Scanner

Laser imaging system or three-dimensional scanner provides the most in-depth geotechnical analysis. When it comes to accuracy, speed, and user friendliness, the three-dimensional scanner is unparalleled. It can provide virtual copies of a mine in minutes with photographic images. The scanner is battery operated and requires no leveling. The system uses a pan and tilt mount that automatically adjusts the scanner to operate in multiple accesses.

The technical aspects of these units are essentially faster and more advanced with systems similar to those found in total stations. The key difference is that instead of making one measurement at a time, the units receive an array of data that cover the entire area at once. For example, these systems acquire 6000–10,000 data points per second.

These systems transmit data to computers in survey office which receive the scanned data almost instantaneously via an Ethernet connection. Depending on the reflection coefficient of the targets, they can scan up to 2500 m with accuracy of 25 mm. The customized software allows the user to specify monitoring points and frequencies for acquiring data. The exact X, Y, and Z coordinates of specified points are programmed in situ to the system. These data are exported in ASCII formats to be comparable with most of the application software.

Contour plots can be made of the strata under observation. It is therefore used for long term monitoring and identifying high areas for ground probe radar. In the absence of stable locations for placing instrument control purposes, global navigation satellite system is an effective method for monitoring points. Laser monitoring, however, has the same disadvantage as the prism monitoring, as it cannot provide early warning of failures for necessary timely action.

1545 n.

Text 3
Global Positioning System and Time-Domain Reflectometer

The GPS can be used to measure the movement and continuous monitoring of slopes in surface mines. This system has antennas spread over the region for monitoring the slope. These antennas use the data from the GPS satellites to determine their relative positions. These positions are then transferred to a central computer connected through a cable that supplies power for the antennas.

The data analyses performed by the computer are used to determine the displacement in the slope that is used to predict possible failures in the slope. The precision of GPS data is indicated by the standard deviations of the measurements across the baseline. Various data processing techniques need to be applied to GPS data for improving precision. The system is cost effective on a long-term basis. However, the system has limited accuracy for measurement of displacement in the slope.

TDR works on the principle of applying an electrical pulse through a conductor and examining the reflected electrical pulse for discontinuities in the conducting material.

The TDR was first used for measurement of rock mass deformations. A drill hole is made in the slope and a coaxial cable is grouted in it for monitoring slope failures. Crimps are placed at regular intervals along the coaxial cable. The crimps reflect the transmitted signals along the coaxial cable. Analysis of the reflected signals from the coaxial cable helps determining rock mass deformation.

Some of the advantages of coaxial cables, when compared to the conventional inclinometers, are lower cost of installation, deeper hole depth, rapid and remote monitoring, and immediate determination of deformation. However, a probe inclinometer can measure very small rock mass movements which are below the threshold limit of TDR.

1546 п.з.

Text 4
Digital Aerial Photogrammetry and Monitoring of a Slope Face Using Geophones

When an object is photographed from two different locations, different lines of sight from each location are obtained. The lines of sight for the object from each location are intersected to produce a three-dimensional image of the object (Fig. 1.9). It thereby helps in constructing a three-dimensional image of the object from different two-dimensional images.

These images are then loaded onto a software, which develops a threedimensional image of the face. From the three-dimensional image, the location of faults, dykes, joints, and potential failure planes are obtained. The process can be repeated at regular intervals to enable the identification of newer failure planes, and therefore identify potential zones of failure.

The advantage of digital photogrammetry is labor saving and it gives the complete knowledge of deformation in a slope face. This technique is cost saving and helps in real-time measurements. However, the technique has limited accuracy for measurement of deformation in slope face.

Geophones are used for measurement of seismic movements that help locate the source and the discontinuity over which the movement occurs. A number of geophones that measure microseismic movements up to 0.001 mm are installed over the open-pit face. Data from all geophones are then analyzed using a computer.

The sensors, which are mostly energized by solar power, have a two way communication with a remote monitoring computer. For proper seismic monitoring, the sensors should surround the rock mass being monitored.

Seismic monitoring can give an indication of the seismic activity of the geologic structure. It also helps identify other unknown geologic structures using the planes of weakness defined by seismic events. The disadvantage of the method is that it cannot predict slope failure accurately.

1543 п.з.

Text 5
Slope Stability Radar

Though the radar technology has been in use in a variety of fields for several decades, it has found its utility recently in monitoring ground movements in mining areas. SSR is now being adopted in different countries to remotely scan a rock slope, continuously monitor spatial deformation of the face and get advance warning signals before any slope or dump failure occurs in opencast mines. Using differential radar interferometry, the system can detect deformation movements of a rough wall with submillimeter accuracy and with high spatial and temporal resolution. The effects of atmospheric variations and spurious signals can be reduced via signal processing means.

The system consists of two main parts: the scanning antenna and radar electronics connected via an umbilical cable.

The radar is moved around the mine in a repeatable manner to compare movements at each site over an extended time and to identify problematic areas.

The radar technology suitably integrated with a real-time visual imaging system can be used for continuously scanning and identifying the potential areas of failure and visualizing any impending ground movement or failure by comparing the repeated measurements against the first scan. Such systems can also have suitable audiovisual warning systems incorporated for activation at any preset value being breached due to ground movements.

The advantage of the SSR over other monitoring techniques is that it provides full area coverage without the need for mounted reflectors or equipment on the pit wall. In addition, the radar waves adequately penetrate through rain, dust, and smoke to provide reliable measurements 24 h a day. However, the system is costly, because good numbers of SSR are required for a large mine with uneven geometry.

1515 п.з.

Text 6
Equipment Tracking System

The equipment tracking module incorporates location, time, and equipment information to create a cohesive picture of a mine's haulage system. The module records virtually every relevant detail of each truck's haulage cycle, including: the arrival time at shovel, queue time, and load time, as well as the location, shovel ID, material, grade, truck size, and load tonnage. Once recorded, these pieces of information are used to determine shovel hang time, truck idle time, and other productivity parameters for dumpers, specific equipment and operators.

Additionally, the position tracking module provides visualization tools that help monitor the position of equipment in real time or run historical reports on equipment position to compare actual movements versus planned movements.

Real-Time Dumper movement and dispatch system creates optimized assignments and maximizes the efficiency of the haulage fleet. The system establishes a historical database based on location of the trucks, time taken to complete the cycle of haulage and equipment information to create an organized picture of mine's haulage system. The system detects when a truck, loader, or auxiliary equipment unit are sitting idle with its engine running and when the user defined idle time threshold is reached. The idle monitor module automatically notifies the dispatch system and puts the equipment in alert status.

The system also has a fueling module that enables manual recording of the fuel and fluids that are added in the system.

1510 п.з.

Text 7
Mine Asset Monitoring System

Mine asset monitoring system overcomes the difficulties of managing hundreds of moving and fixed assets at mine sites. This system allows one to remotely locate the facility of missing equipment, improve equipment utilization, and prevent theft system runs with a web-based server, network clients, and webbased viewers. It uses low-cost hardware within a self-healing wireless mesh network to communicate asset data back to the central computer. The system uses a small durable device called the asset node, which is equipped with an onboard GPS, analog input, two digital inputs as well as outputs and digital accelerometer. The asset node can be easily attached to any asset, mobile or fixed including: cranes, trucks, pumps, generators, etc.

The system monitors the activities of dumpers/shovels/auxiliary equipment to make sure that no equipment is in the idle state. It also monitors the production of different minerals and generates grade-wise production reports for analyzing the productivity of the entire system over a unit period. Development of mine transport surveillance and production management system is a step forward in checking overloading of minerals on truck and dumpers and their efficient disposal from a mine site and, at the same time, the stopping of illicit mineral transportation through unauthorized routes. The system also provides efficient production management techniques that help mine authorities by taking steps for full utilization of human resources, as well as optimization of shovels, dumpers, and other mining machinery.

1550 п.з.

Text 8
Mine Gas Monitoring Techniques

Underground coal mines generally use a portable gas monitoring device, real time monitoring system, tube bundle, and gas chromatography to meet their gas monitoring requirements. Besides regulatory requirements, selection, use and scope of these systems often depend on an individual mine with regard to factors such as gas content of seam and its propensity for oxidation.

The industry has realized that all four techniques are necessary for effective monitoring of the mine's atmosphere. Each technique has advantages and disadvantages that must be known to those who are using the systems and utilizing the results in order to interpret the status of the underground environment. Successful application of mine gas monitoring systems requires setting of appropriate alarms that trigger effective remedial actions. A mine must also implement effective maintenance and calibration procedures to ensure reliable monitoring of mine gases.

Gas composition can be determined by in situ direct measurement using portable gas sensors. These need frequent calibration based on several gas standards covering the range of interest. Relative uncertainties in readings are generally less than 5%. Portable gas detectors can monitor:

• a single specific gas, eg, methane, carbon dioxide, etc.;
• all VOC gases, or total hydrocarbon gases;
• all flammable gases;
• oxygen; and
• a combination of flammable gas(es), oxygen, carbon dioxide, and other gases, such as hydrogen sulfide or nitrous oxide.

Separate sensors are used for each gas or group of gases and the values are reported separately.

Portable gas detectors are point source detectors. They measure the concentration of gas at a sampling point. The unit of measurement is % by volume for flammable gases, ppm or mg/m3 for low level concentration gases (and toxic gases).

Text 9
Comparison Between Catalytic Bead Sensor and IR Gas Sensor

Catalytic sensors are considered to be a well-established technology for detecting combustible gases. However, it is expected that new and improved features available with IR technology would encourage for more utilization of IR sensors than catalytic sensors. Moreover, catalytic sensors are more prone to poisoning and cracking.

IR sensors provide high accuracy, resistance to contamination, and reliable measurements. Unlike a catalytic bead sensor, a gas sample enters and leaves the cell unchanged. Nothing is transformed, substituted, or removed from it. As the IR source ages, its energy level decreases. However, there is only one source; therefore, the energy level reduction equally affects both the sensor tubes (reference and detection) and no imbalance is detected. There is no need of extreme temperature for detection, resulting in less stress on construction materials. As there is no combustion, corrosive byproducts are not produced.

All the electronics and active components are sealed to keep them separated from the combustible gas environment. Therefore, there is no inhibitor, which helps in providing improved gas response.

However, close coupling of electronics to IR sensors limits operation at high temperature. In high temperature, these sensors can cause drift or failure. Due to high cost of components and assembly, the initial prices of IR sensors are more than those of catalytic detectors. These sensors fail to detect some of the combustible gases (eg, hydrogen). Moreover, humidity, water, dust, and dirt can affect the sensor's response.

1568 п.з.

Text 10
Piezometers

Piezometers are devices used to monitor pore and joint water pressures in boreholes. The most commonly used device is an electrical water level sensing probe that is used in combination with uncased boreholes (observation wells) to determine the depth to the water table by means of lowering the probe down the borehole. When the probe comes in contact with the water, an electrical circuit is completed, and the device makes an audible noise. Although this technique is quick and inexpensive and provides useful data in the initial stages of a project, it may be unreliable, especially in the presence of perched water tables, vertical groundwater gradients, and artesian conditions.

Open standpipe piezometers involve cased boreholes, perforated at the depth of interest, in combination with a polyvinyl chloride (PVC) standpipe with a sealed-off porous filter element attached at the end. A sand filter zone is placed in the annulus around the filter tip up to the top of the filter zone with the remaining borehole backfilled with a bentonite grout to prevent any flow of water into the filter from other horizons. An electrical sensing probe can then be used to measure the water level corresponding to the groundwater pressure for the monitored interval. Combined standpipe/inclinometer installations are possible and are commonly used at surface mining operations.

The principal differences between the various types of piezometers include the following:

• Single-point or multipoint measurements,

• Vibrating wire, pneumatic, fiber-optic, strain gauge, or micro-electromechanical system- (MEMS-) based sensors,

• Conventional installation or push-in types for soft ground.

1437 п.з.

Text 11
Modes of Instrument Operation

Monitoring of strata conditions in mines may be carried out for a variety of reasons, including obtaining data needed for mine design, such as rock mass deformability or rock stresses; verifying design data and assumptions; assessing the effectiveness of existing ground support; and warning of potential ground failures.

Various modes of instrument operation exist to monitor strata conditions in mines: mechanical, optical, hydraulic and pneumatic, electrical, and electro-mechanical types.

The mechanical type often provides the simplest, cheapest and most reliable methods of detection, transmission, and readout. Mechanical movement detectors use a steel rod or tape, fixed to strata at one end, and in contact with a dial gauge or electrical system at the other. The main disadvantage of a mechanical system is that they do not lend themselves to remote reading or to continuous recording.

The optical type is used in conventional, precise, and photogrammetric surveying methods of establishing excavation profiles, measuring movements of excavation boundaries, and monitoring surface subsidence. In the hydraulic and pneumatic type diaphragm transducers are used for measuring water pressures, support loads, and so forth. The quantity measured is a fluid pressure which acts on one side of a flexible diaphragm made of a metal, rubber, or plastic.

The electrical type is the most common instrument mode used in mines. Electrical systems operate on one of four principles, i.e. electric resistance, micro-electro-mechanical systems (MEMS), vibrating wire, and self-inductance.

1569 п.з.

Text 12
Creation of 3d Underground Mine Model

A lack of accurate maps of underground mines poses a serious threat to miner's safety. People working underground generally face many dangers such as suffocation, falling rocks, explosions, etc. Therfore, there is a great need for fast and reliable 3D scanning and model building of underground mines.

A number of sensors are available for the 3D modeling of mine faces of both underground and surface mines. These include photogrammetry packages and laser scanners.

Photogrammetry systems capture high-resolution images using off-the-shelf digital single-lens reflex cameras, and the software processes images to recover 3D information. Typically, a reference object and a survey point are required in the scene to scale and georeference the 3D model. These systems only collect images onsite, which are processed afterwards on surface to generate photorealistic 3D models.

Laser scanners collect a dense 3D point cloud by measuring time-of-flight of laser. These have a long operating range and high accuracy. At present, many systems are available for developing a 3D model of underground mine. Most of these systems are robot based.

Underground mine roadways are rough and inclined; therefore, robots do not work properly. Mobile underground mine mapping technology is a lightweight handheld laser-scanning device coupled with data processing software capable of accurately estimating the position and orientation of the scanner over time as it moves through the environment. Scanner measures tens of thousands of ranges per second from sensor origin to points on various physical surfaces using narrow IR laser pulses. For an accurate estimation of the scanner's motion, a set of measurements can be projected into x, y, z points in a common coordinate frame, thereby generating a consistent point cloud model of underground mines.

1591 п.з.

Text 13
Control and Monitoring Instrumentation for Oil & Gas

Industrial instrumentation is used to control and monitor conditions including temperature, pressure and fluid levels in processing facilities, oil refineries, petrochemical plants, oil and gas pipelines, and distribution operations. Common applications of oil and gas instrumentation include monitoring the presence of flammable and combustible gases in production and storage areas and monitoring emissions for pollution control. Instrumentation is also used for monitoring and controlling flow in delivery systems.

There are two types of instrumentation used in equipment monitoring: input and output. Input instruments are used to monitor or measure temperature, flow, pressure and levels in equipment including transport pipes and vessels. Output instruments, on the other hand, include controls and alarms that display readings or provide an alert to warn of potentially hazardous situations.

The three primary components of industrial instrumentation are sensors, transducers and transmitters.

- **Sensors**: measure the physical properties of a solid, fluid or gas. In the oil and gas industry, sensors provide continuous measurement to detect and monitor gas and gas emissions.
- **Transducers**: convert variations in temperature, pressure, flow or level into an electric signal that is then picked up by a transmitter.
- **Transmitters**: serve as an interface between sensors and measurement instrumentation such as level sensors, flow meters, and pressure sensors.

The oil and gas industries process a variety of hazardous substances that can cause explosions or catastrophic events and endanger the safety of humans and the environment. Field instrumentation provides monitoring and control that is essential for ensuring compliance with safety and environmental regulations.

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Text 14
Considerations for Selecting Oil and Gas Instrumentation

Instrumentation for effective and reliable control and monitoring of petroleum processing equipment includes:

- **Gas Analytics Equipment** includes continuous gas analyzers, toxic gas detectors, flame detection sensors, and gas analysis systems for monitoring toxic and combustible gases, oxygen depleting gases and emissions.
- **Pressure Instrumentation** includes a variety of pressure gauges, switches and transmitters that provide real-time measurement of your process in tanks, vessels & piping, and display in engineering units such as PSI, BAR, vacuum, in H2O and more.
- **Temperature Monitoring Instrumentation** includes manual and automated field instruments that are used to measure and monitor temperature fluctuations in critical and non-critical applications. Different types of temperature instrumentation include heaters, controllers, thermal imagers, and infrared pyrometers.
- **Flow Meters** measure the flow of gas, oil and other substances through pipes and channels. Options include instruments for thermal mass flow, open channel flow, positive displacement flow, Ultrasonic flow etc.
- **Level Sensors** provide point level and continuous level measurement for various oil and gas applications including monitoring levels in tanks and other vessels. Oil & gas level sensors are integrated into control systems to provide a visual or audible signal when levels become dangerously low or high.
- And more

It is important to consider the following criteria when researching options for oil and gas instrumentation:

- Operating conditions
- Performance Characteristics
- Maintenance Requirements
- Reliability & Durability
- Impact on Processes.

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ПРИБОРОСТРОЕНИЕ. ПРИБОРЫ И СИСТЕМЫ ГОРНОГО И ТЕХНИЧЕСКОГО КОНТРОЛЯ

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