ДОНСКОЙ ГОСУДАРСТВЕННЫЙ ТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

УПРАВЛЕНИЕ ЦИФРОВЫХ ОБРАЗОВАТЕЛЬНЫХ ТЕХНОЛОГИЙ

Кафедра «Иностранный язык в сфере технических наук и технологий»

Учебно-методическое пособие

по дисциплине

«Иностранный язык (английский)»

Авторы
Зимина В.П.,
Фомичева Е.В.

Ростов-на-Дону, 2023

Аннотация

Методические указания содержат профессионально – ориентированные тексты на английском языке для студентов, обучающихся по направлению 15.03.04 «Автоматизация технологических процессов и производств», а также упражнения, способствующие развитию навыков чтения, перевода и устной речи.

Авторы

ст. преподаватель кафедры «Иностранный язык в сфере технических наук и технологий»
Зимина В.П.

ст. преподаватель кафедры «Иностранный язык в сфере технических наук и технологий»
Фомичева Е.В.

Contents

Text 1. Automation

Task 1. Read the following words and word combinations to the text and remember them:

assembly – автоматическая сборка;
automata – автоматы, роботы, автоматика;
automatic transfer machining – обработка в автоматической линии;
communication engineering – технические средства связи;
continuous cycle – непрерывный цикл;
control engineering – техника управления;
float-type controller - поплавковый регулятор;
self-checking – самоконтролируемый;
self-feeding – автоматическая подача;
self-initiating – автоматический пуск;
speed governor – регулятор скорости**;**
weaver – ткач, ткачиха;
weaving loom – ткацкий станок;

Task 2. Read the text and try to understand it:

It is well known that since ancient time people have tried to construct automatic toys. Those toys were put into motion by hidden mechanisms of automatic devices. The mechanical wonders of the past indicated the road for developing automatic systems later. Clocks and watches, being the first automatic systems, suggested people an idea of producing automata in industrial manufacture. The Frenchman Vaucanson built a weaving loom replacing fifty weavers. The talented Russian mechanic Ivan Polzunov invented a float-type controller for his steam engine. Steam engine found universal application due to the invention of the centrifugal speed governor, designed by the English inventor James Watt. Soon automation spread to all technological spheres and became a moving force of technological advance.

So, automation deals with the theory and construction of control systems which can function without man's participation. It should be noted that modern automatic industrial process involves four independent components, each component becoming more powerful in the presence of the other. They are: transfer machining, automatic assembly, communication engineering and control engineering. These four components are linked together into a single process called *automation.* When two or more automatic machines are connected together with automatic controls, which may be mechanical, electrical or a combination of them, an automated control is formed. This system creates a self-feeding, self-initiating and self-checking process.

It should be noted that electronics has greatly extended the range of automatic control and has made the processing of information rapid and automatic. Electronic devices are able to respond very quickly to signals and take measurements and detect faults very accurately. So, they can effectively control many processes and machines working at high speeds. Due to the above mentioned advantages, automatic control systems find wide application in many fields of technology. Automatic controls relieve man of many monotonous activities. Besides, they can perform functions which are beyond the physical abilities of a man.

People make great use of automation in industry; it is especially effective in continuous cycle production. Various kinds of electronic devices are applied in automatic aircraft pilots, as radio aids to air and marine navigation. Owing to automation special devices make precise calculations for space vehicle movement, help to launch missiles and to direct them to the correct path. Automatic interplanetary stations and space rockets are equipped with orientation systems, photo-television apparatus, special soft landing radio systems and movement control systems of high precision. These systems ensure safe returning and safe landing.

Task 3. Give the English equivalents for the following Russian words and expressions:

паровой двигатель, движущая сила, технологический прогресс, функционировать без участия человека, следует отметить, диапазон автоматического управления, обработка информации, реагировать очень быстро; обнаружить неисправность, работать на высоких скоростях, система автоматического управления, найти широкое применение, физические возможности человека, благодаря автоматизации, межпланетная станция, точные расчеты, траектория, космический корабль.

Task 4. Say whether these sentences are true or false, correct the false ones.

1. Functioning without man's participation is the essence of automation.
2. Ivan Polzunov invented a float-type controller for his weaving loom.
3. Each component of four independent components becomes less powerful in the presence of the other.
4. Electronics has greatly narrowed the range of automatic control.
5. Automatic control systems find little application in many fields of technology.
6. Electronic devices are only able to respond very quickly to signals.
7. Automated control creates a self-feeding, self-initiating and self-checking process.
8. Automation helps to make precise calculations for space vehicle movement.

Task 5. Answer the questions:

1. What suggested people an idea of producing automata in industrial manufacture? 2. Why did steam engine find universal application?
3. What did James Watt invent?
4. What does automation deal with?
5. What independent components does modern automatic industrial process involve? 6. What is called automation?
7. What can effectively control many processes and machines working at high speeds?
8. Which systems ensure safe returning and safe landing?
9. Which spheres is automation primarily used in?
10. What do movement control systems of high precision provide?

Text 2. The Digital Computer

Task 1. Read the following words and word combinations to the text and remember them:

adaptive control – адаптивное управление;
approximate method – приближенный метод;
closed loop control – регулирование в замкнутом контуре;
control engineering – техника автоматического управления и регулирования, техника контроля**;**

direct digital control – прямое числовое программное управление;
frequency response – частотная характеристика;
fuzzy control – нечеткое управление;
knowledge-based control – управление с использованием базы знаний;
learning control – управление с обучением;
loop – цикл, контур;
plugboard – штепсельная панель;
proper – *зд.* собственно;
reliable – надежный;
root locus design – синтез с помощью метода корневого годографа;
ruggedized – в полевом исполнении, предназначенный для эксплуатации в тяжелых условиях;
sequential logic control – последовательное логическое управление**;**
servos – исполнительные приводы, сервомеханизмы;
to supersede – вытеснить;
three-term – трехканальный**;**

Task 2. Read the text and try to understand it:

The introduction of digital technologies in the late 1950s brought enormous changes to automatic control.

Control engineering had long been associated with computing devices – as noted above, a driving force for the development of servos was for applications in analogue computing. But the great change with the introduction of digital computers was that ultimately the approximate methods of frequency response or root locus design, developed explicitly to avoid computation, could be replaced by techniques in which accurate computation played a vital role.

The earliest systems were supervisory systems, in which individual loops were controlled by conventional electrical, pneumatic or hydraulic controllers, but monitored and optimized by computer. Specialized process control computers followed in the second half of the 1960s, offering direct digital control (DDC) as well as supervisory control.

In DDC the computer itself implements a discrete form of a control algorithm such as three-term control or other procedure. Such systems were expensive, however, and also suffered many problems with programming, and were soon superseded by the much cheaper minicomputers of the early 1970s. But, as in so many other areas, it was the microprocessor that had the greatest effect.

Microprocessor-based digital controllers were soon developed that were compact, reliable, included a wide selection of control algorithms, had good communications with supervisory computers, and comparatively easy to use programming and diagnostic tools via an effective operator interface. Microprocessors could also easily be built into specific pieces of equipment, such as robot arms, to provide dedicated position control, for example.

A development often neglected in the history of automatic control is the programmable logic controller (PLC). PLCs were developed to replace individual relays used for sequential (and combinational) logic control in various industrial sectors. Early plugboard devices appeared in the mid 1960s, but the first PLC proper was probably the Modicon, developed for General Motors to replace electromechanical relays in automotive component production. Modern PLCs offer a wide range of control options, including conventional closed loop control algorithms such as PID as well as the logic functions. In spite of the rise of the ruggedized PCs in many industrial applications, PLCs are still widely used owing to their reliability and familiarity.

(The classic example is in flight control, where the altitude affects aircraft dynamics, and needs therefore to be taken into account when setting gain.) Digital adaptive control, however, offers much greater possibilities for:

1. Identification of relevant system parameters.
2. Making decisions about the required modifications to the control algorithm.
3. Implementing the changes.

Optimal and robust techniques too, were developed, the most celebrated perhaps being the linear-quadratic- Gaussian (LQG) and $H\infty$ approaches from the 1960s onwards. Without digital computers these techniques, that attempt to optimize system rejection of disturbances (according to some measure of behaviour) while at the same time being resistant to errors in the model, would simply be mathematical curiosities.

A very different approach to control rendered possible by modern computers is to move away from purely mathematic models of system behaviour and controller algorithms. In fuzzy control, for example, control action is based on a set of rules expressed in terms of *fuzzy* variables. For example

IF the speed is "high"
AND the distance to final stop is "short"
THEN apply brakes "firmly".

The fuzzy variables *high*, *short* and *firmly* can be translated by means of an appropriate computer program into effective control for, in this case, a train. Related techniques include *learning control* and *knowledge-based control*. In the former, the control system can *learn* about its environment using artificial intelligence techniques (AI) and modify its behavior accordingly. In the latter, a range of AI techniques are applied to reasoning about the situation so as to provide appropriate control action.

(by C.C. Bissell, *A History of Automatic Control*)

Task 3. Give the English equivalents for the following Russian words and expressions:

цифровые технологии; вычислительные устройства; движущая сила; аналоговая вычислительная система; эксплицитно; точное вычисление; контролирующая система; традиционный контроллер; супервизорное управление; алгоритм управления; оказать влияние; позиционное управление; манипулятор робота (рука робота); логический контроллер; испытывать проблемы; электромеханическое реле; адиабатическое размагничивание; программируемый логический контроллер; магнитные диполи; электронная оболочка; степень подвижности; критерий поведения; любознательность, курьез; набор правил.

Task 4. Say whether these sentences are true or false, correct the false ones.

1. Digital technologies greatly changed automatic control.
2. Analogue computing offered direct digital control.
3. Microprocessor-based digital controllers were not compact and reliable.
4. An effective operator interface is used as a programming and diagnostic tool.
5. A programmable logic controller was often neglected in the

history of automatic control.

6. The first programmable logic controller was to replace electromechanical relays.

7. A modern approach to control is considered to be a mathematic model of system behaviour.

8. Fuzzy variables cannot be translated into effective control.

9. In knowledge-based control a range of AI techniques are applied to learn about the environment.

Task 5. Answer the questions:

1. What brought enormous changes to automatic control?
2. What was a driving force for the development of servos?
3. How can you describe the earliest systems?
4. What followed in the second half of the 1960s?
5. What kind of problems did DDC suffer?
6. What features did microprocessor-based digital controllers possess?
7. What were programmable logic controllers developed for?
8. Why are PLCs still used?
9. What does digital adaptive control offer?
10. What kind of approach do modern computers suggest?
11. How is artificial intelligence in the techniques including learning control and knowledge-based control used?

Text 3. Open and closed loop systems

Task 1. Read the following words and word combinations to the text and remember them:

feedback – обратная связь;
closed loop system – система с обратной связью;
CNC – computer numerical control (числовое программное управление);
high-end – высокотехнологичный**;**
limit switch – конечный выключатель;
open loop system – система без обратной связи;
order of magnitude – порядок (величины)**;**
proportional–integral–derivative controller – пропорционально-интегральный дифференциальный регулятор (ПИД-

регулятор);

to outfit – оснащать;

to output – выводить (данные);

to relay – перенаправлять;

set point – заданная величина;

step and direction signals – сигналы о шагах и направлениях перемещений;

tolerance – допустимое отклонение;

to trip – *зд.* отключать

Task 2. Read the text and try to understand it:

The open and closed loop systems describe the two primary types of CNC control systems. Open and closed loops describe the control process of a system. Open loop refers to a system where the communication between the controller system and the motor is one way.

The process for an open loop system is simple. After the user decides what he/she wants to do and generates the g-code or some sort of work file, the NC software then creates the necessary step and direction signals to perform the desired task. The computer relays this information to the controller which then energizes the motor/s. After the motor moves to the desired position, there is no feedback to the controller system to verify the action.

In the CNC industry, open loop systems use stepper motors. However, just because a system uses stepper motors, it does not mean the system is an open loop system. Stepper motors may be outfitted with encoders to provide position feedback just like servo motors

Stepper motors are able to operate in an open loop system while servo motors are not, for CNC applications at least. Because stepper motors do not require feedback hardware, the price for an open loop CNC system is much cheaper and it is simpler than a closed loop system. This makes it more affordable for hobbyists to build their own CNC machine.

There are drawbacks of the open loop system. Because there is no feedback to the controller, if the motor does not operate as instructed there is no way for the system to know about this problem. The controller system will continue performing the next task as if there is no problem until a limit switch is tripped or the operator resets the machine.

The closed loop system has a feedback system to monitor the output of the motors. Closed systems are also able to correct errors in position, velocity, and acceleration, and also fault the system if the error is too large.

There are two types of closed loop systems. The first type returns the feedback to the CNC controller, and the second one returns the feedback into the computer. Both systems are true closed loop systems. The system where the feedback is fed into the signal generator or computer is usually found on high-end machines.

The most common type of closed loop controller system is the system where an encoder, glass scale, or some other type of analog device is responsible for the feedback signal.

Most of these closed loop controllers are PID or proportional–integral–derivative controllers. The encoder output is fed into the motor driver. A PID controller attempts to correct the error between a measured variable and a desired set point by calculating and then outputting a corrective action that can adjust the process accordingly and rapidly, to keep the error minimal.

This type of control loop is set to fault at a preset value. This should stop the machine in case of excess error. Some people believe that this type of system can be inaccurate. This is untrue if setup is done properly. The resolution of this type of servo system should be designed to be one order of magnitude more precise than the machine. With this setup, even if the machine were to fault, the error is still less than the machine tolerance.

The disadvantages of closed loop systems are cost and complexity. Closed loop controllers can be harder to tune and have more parts that could fail.

Task 3. Give the English equivalents for the following Russian words and expressions:

шаговый двигатель; разработчик-любитель; стеклянная шкала; быть ответственным за; аналоговое устройство; регулировать процесс; драйвер двигателя; данные датчика; обеспечивать минимальную погрешность; измеренная переменная; регулировать процесс соответственным образом; предварительно заданная величина; установлен на погрешность/ошибку; избыточная погрешность; труднее регулировать/настроить; на один порядок точнее.

Task 4. Fill in the blanks with the proper words:

1. Open and closed loops describe the … process of a system.
2. The NC software creates the necessary step and direction signals … the desired task.
3. … motors may be outfitted with encoders to provide position feedback just like … motors.
4. The closed loop system has a feedback system … the output of the motors.
5. There are two types of … loop systems.
6. A PID controller attempts to correct the error between a … variable and a … set point.
7. The disadvantages of closed loop systems are … and … .

Task 5. Answer the questions:

1. What kind of control does an open loop system perform?
2. What kind of motors do the open loop systems use in CNC industry?
3. Why is the price for an open loop CNC system much cheaper?
4. What are the drawbacks of the open loop system?
5. What errors are the closed systems able to correct?
6. What is the most common type of the closed loop controller system?
7. How can a PID controller correct the error between a measured variable and a desired set point?
8. What stops the machine in case of an excess error?
9. What kind of controllers has more parts that can fail?

Text 4. Data acquisition

Task 1. Read the following words and word combinations to the text and remember them:

acquisition – сбор и обработка (данных);
application – *зд.* применяемая техника;
breakout box – распределительный щит;
bus – шина, магистральный канал;
data acquisition (DAQ) card – плата сбора данных;
flexible – универсальный;
general purpose – универсальный, стандартный;
linearization – спрямление, линеаризация;
to manipulate – обрабатывать;

multiplexer – мультиплексер, уплотнитель каналов;
sampling – измерение, съем (данных);
sensor – датчик;
serial – последовательный;
signal conditioning – формирование сигнала;
stand-alone logger – отдельный регистратор данных;
voltage ramp – линейное измерение напряжения;
waveform – сигнал.

Task 2. Read the text and try to understand it:

Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems (abbreviated with the acronym **DAS** or **DAQ**) typically convert analog waveforms into digital values for processing. The components of data acquisition systems include:

- Sensors that convert physical parameters to electrical signals.
- Signal conditioning circuitry to convert sensor signals into a form that can be converted to digital values.
- Analog-to-digital converters, which convert conditioned sensor signals to digital values.

Data acquisition applications are controlled by software programs developed using various general purpose programming languages such as BASIC, C, Fortran, Java, Lisp, Pascal.

Specialized software tools used for building large-scale data acquisition systems include EPICS. Graphical programming environments include ladder logic, Visual C++, Visual Basic, and Lab VIEW.

Data acquisition begins with the physical phenomenon or physical property to be measured. Examples of this include temperature, light intensity, gas pressure, fluid flow, and force. Regardless of the type of physical property to be measured, the physical state that is to be measured must first be transformed into a unified form that can be sampled by a data acquisition system. The task of performing such transformations falls on devices called *sensors*.

A sensor, which is a type of *transducer*, is a device that converts a physical property into a corresponding electrical signal (e.g., a voltage or current) or, in many cases, into a corresponding electrical characteristic (e.g., resistance or capacitance) that can easily be converted to an electrical signal.

The ability of a data acquisition system to measure differing properties depends on having sensors that are suited to detect the various properties to be measured. There are specific sensors for many different applications. DAQ systems also employ various signal conditioning techniques to adequately modify various electrical signals into voltage that can then be digitized using an Analog-to-digital converter (ADC).

Signals may be digital (also called logic signals) or analog depending on the transducer used.

Signal conditioning may be necessary if the signal from the transducer is not suitable for the DAQ hardware being used. The signal may need to be amplified, filtered or demodulated. Various other examples of signal conditioning might be bridge completion, providing current or voltage excitation to the sensor, isolation, and linearization. For transmission purposes, single ended analog signals, which are more susceptible to noise, can be converted to differential signals. Once digitized, the signal can be encoded to reduce and correct transmission errors.

DAQ hardware is what usually interfaces between the signal and a PC. It could be in the form of modules that can be connected to the computer's ports (parallel, serial, USB, etc.) or cards connected to slots (S-100 bus, Apple Bus, ISA, MCA, PCI, PCI-E, etc.) in the motherboard. Usually the space on the back of a PCI card is too small for all the connections needed, so an external breakout box is required. The cable between this box and the PC can be expensive due to the many wires, and the required shielding.

DAQ cards often contain multiple components (multiplexer, ADC, DAC, TTL-IO, high speed timers, RAM). These are accessible via a bus by a microcontroller, which can run small programs. A controller is more flexible than a hard wired logic, yet cheaper than a CPU so that it is permissible to block it with simple polling loops. For example: Waiting for a trigger, starting the ADC, looking up the time, waiting for the ADC to finish, move value to RAM, switch multiplexer, get TTL input, let DAC proceed with voltage ramp. Many times reconfigurable logic is used to achieve high speed for specific tasks and digital signal processors are used after the data has been acquired to obtain some results. The fixed connection with the PC allows for comfortable compilation and debugging. Using an external housing a modular design with slots in a bus can grow with the needs of the user.

Not all DAQ hardware has to run permanently connected to a PC, for example intelligent stand-alone loggers and oscilloscopes, which can be operated from a PC, yet they can operate completely independent of the PC.

Task 3. Give the English equivalents for the following Russian words and expressions:

физическое состояние; преобразовать аналоговый сигнал в цифровое значение; программный продукт; независимо от; единая форма; соответствующий электрический сигнал/характеристика; обнаружить различные свойства; с целью передачи; односторонние аналоговые сигналы; материнская плата; более гибкий, чем; переналаживаемый логический блок; дифференциальный сигнал; цифровой процессор сигналов.

Task 4. Say whether these sentences are true or false, correct the false ones.

1. Data acquisition systems typically convert digital waveforms into analog values.
2. Programming languages control data acquisition applications.
3. The physical state to be measured must first be transformed into a unified form.
4. There are universal sensors for many different applications.
5. Digital signals are also called logic signals.
6. All DAQ hardware has to run permanently connected to a PC.
7. A microcontroller can run small programs.
8. Single ended analog signals are susceptible to noise.

Task 5. Guess or look up in a dictionary or some other reference materials the meanings of the following abbreviations or acronyms:

USB, ISA, MCA, PCI, PCI-E, ADC, DAC, TTL, TTL-IO, RAM.

Task 6. Answer the questions:

1. What is data acquisition?
2. What are the components of data acquisition systems?
3. What do data acquisition systems convert?

4. What programming languages are used for developing software programs to control data acquisition applications?
5. What devices transform the physical state into a unified form?
6. What does the ability of a data acquisition system to measure differing properties depend on?
7. In what case may signal conditioning be necessary?
8. Which ones are similar to each other?
9. Where are such slots as S-100 bus, Apple Bus, ISA, MCA, PCI, PCI-E located?
10. What components do DAQ cards often contain?

Task 7. Fill in the blanks with the proper words.

1. Data acquisition is the process of ______ signals that measure real world physical conditions.
a) transmitting; b) sampling; c) correcting

2. Specialized ________ tools are used for building large-scale data acquisition systems.
a) software; b) hardware; c) information

3. A sensor is a device that converts a physical __________ into a corresponding electrical signal.
a) data; b) appearance; c) property

4. DAQ systems use various signal conditioning ________ to adequately modify various electrical signals into voltage.
a) computers; b) models; c) techniques

5. DAQ __________ is what usually interfaces between the signal and a PC.
a) hardware; b) software; c) engineering

6. A controller is ___________ than a CPU.
a) more expensive; b) cheaper; c) the best

7. The fixed ________ with the PC allows for comfortable compilation and debugging.
a) design; b) connection; c) construction.

Text Compression

Среди основных этапов научно-информационной деятельности важное место занимает аналитико-синтетическая переработка поступающей информации на родном и иностранных языках, включающая перевод с одного языка на другой, обзоры, аннотирование, реферирование и т.д.

Реферат (Review) — это сжатое, краткое изложение текста с основными фактическими данными, выводами и рекомендациями. По полноте изложения содержания печатного текста рефераты принято делить на рефераты-резюме и рефераты-конспекты.

Требования к составлению реферата:

1. Реферат строится на основе ключевых фрагментов, выделенных из текста.
2. Реферат должен быть написан литературным языком с использованием научной терминологии, принятой в научной литературе по той или иной отрасли науки и техники.
3. Реферат должен объективно и точно отражать содержание первоисточника; нельзя вносить какие-либо изменения или дополнения по существу реферируемой работы.
4. Не следует в реферате излагать собственную точку зрения или критические замечания.

Структура реферата:

1) Выходные данные источника: фамилия и инициалы автора, заглавие, издательство, место, год издания (для журнала — название и номер).
2) Главная мысль, идея реферируемого материала.
3) Изложение содержания: реферируемый материал излагается в последовательности, в которой он приводится в тексте.
4) Выводы автора или результаты исследований.

Порядок работы над рефератом:

1. Просмотреть текст с целью ознакомления с его содержанием.
2. Ознакомиться с графической частью (чертежами, схемами, таблицами

и т.п.) с целью уточнения содержания текста при чтении.

3. Выделить абзацы текста, содержащие основную информацию, подтверждающую, раскрывающую и уточняющую заглавие текста.

4. Опустить второстепенную информацию.

5. Повторно прочитать выделенные абзацы.

6. Преобразовать сложные синтаксические конструкции в более простые.

8. Обобщить отдельные сведения в единый связный текст.

9. Записать полученную сокращенную информацию по указанной выше схеме.

Аннотация (Abstract / Summary) — это краткая характеристика текста с изложением наиболее важных положений. Основным отличием аннотации от реферата является то, что реферат дает представление о содержании оригинала, а аннотация — только о его тематике. Аннотация перечисляет, называет проблемы оригинала, но не раскрывает их.

По целевому назначению и содержанию аннотации подразделяются на справочные и рекомендательные (или информационные и описательные), специализированные и общие.

Требования к составлению аннотации:

1. При составлении аннотации следует избегать сложных конструкций и предложений.
2. Аннотацию необходимо составлять, сохраняя логическую структуру текста.
3. Для обобщения информации рекомендуется использовать специальные обороты и фразы-клише, приведенные ниже.
4. Названия фирм, компаний следует давать в их оригинальном написании; аббревиатуры и различные сокращения необходимо использовать в соответствии с общепринятыми в справочной литературе.

Структура аннотации:

1) Выходные данные источника: фамилия и инициалы автора, заглавие, издательство, место, год издания (для журнала — название и номер).

2) Введение общей темы.

3) Предельно краткое изложение основных вопросов, рассматриваемых в тексте.

4) Общие выводы или заключения автора статьи, эмоционально-оценочное отношение составителя аннотации к аннотируемому тексту.

Список выражений, рекомендуемых для написания реферата и аннотации:

1. The article (text) is entitled ... The article is head-lined ...	Статья озаглавлена ...
2. The author of the article is ... The article is written by ...	Автор статьи — ... Статья написана ...
3. It is (was) published in ...	Она (была) опубликована в ...
4 .The main idea of the article is ... The subject of information is ... The article deals with ... The text is about ... The article is devoted to ... The article touches upon ... The article describes ...	Основная идея статьи ... Тема сообщения ... Статья рассматривает ... В тексте сообщается о ... Статья посвящена ... Статья затрагивает ... Статья описывает ...
5. The author reports (states, stresses, thinks) ... It is pointed out that... It is stressed that ... It is shown that... The problems of ... are considered Special attention is given to ... An important information is given on..	Автор сообщает (заявляет, подчеркивает, думает) ... Указывается, что ... Подчеркивается, что ... Показано, что ... Рассматриваются проблемы ... Особое внимание уделяется ... Предоставляется важная информация о ...
6. The conclusion is made that ... Conclusions are drawn ... The author comes to the conclusion that ...	Делается вывод о ... Делаются выводы ... Автор приходит к выводу, что...

7. The article is of importance (interest) to ...	Статья важна (представляет интерес) для ...

Text 5. SCADA centers

Task 1. Read the following words and word combinations to the text and remember them:
city gate station – замерная станция подачи газа;
dedicated – специального назначения;
fiber-optic line - волоконно-оптическая линия связи;
hard-wired system– система с жесткой логикой;
instrument – прибор;
lag time – разрыв во времени;
leased – арендованный;
master terminal unit – основной терминал;
readings – показания (прибора);
remote terminal unit – устройство связи с объектом;
retrofit – модифицированная установка;
spread-spectrum technology – технология расширенного спектра;
supervisory control and data acquisition (SCADA) system – система диспетчерского контроля и сбора данных.

Task 2. Read the text and try to understand it:

Natural gas pipeline companies have customers on both ends of the pipeline — the producers and processors that input gas into the pipeline and the consumers and local distribution companies that take gas out of the pipeline. To manage the natural gas that enters the pipeline and ensure that all customers receive timely delivery of their portion of this gas, sophisticated control systems are required to monitor the gas as it travels through all sections of a potentially very lengthy pipeline network. To accomplish the task of monitoring and controlling the natural gas that is traveling through the pipeline, centralized gas control stations collect, assimilate, and manage the data received from monitoring city gate stations and compressor stations all along the pipeline.

Most of the data that is received by a control station is provided by supervisory control and data acquisition (SCADA) systems. These systems are essentially sophisticated communications systems that take measurements and collect data along the pipeline (usually in metering or compressor stations and valves) and transmit the data to the centralized control station. Flow rate through the pipeline, operational status, pressure, and temperature readings may all be used to assess the status of the pipeline at any one time. These systems also work in real time, so there is little lag time between taking measurements along the pipeline and transmitting them to the control station. Equipment status scans are taken every 6 to 90 seconds depending on the communication technology used in the field. This information allows pipeline engineers to know exactly what is happening along the pipeline at all times, which permits quick reactions to equipment malfunctions, leaks, or any other unusual activity along the pipeline, as well as to monitoring load control.

Some SCADA systems also incorporate the ability to operate certain equipment along the pipeline remotely, including compressor stations, which allows engineers in a centralized control center to adjust flow rates in the pipeline immediately and easily. Control and monitoring are conducted by using remote terminal units (RTUs), which are placed at intervals along the pipeline, at compressor stations, city gate/measurement stations, underground storage fields, and other related locations. RTUs periodically collect data from field instruments that measure pressure, temperature, flow, and heat content of the natural gas. The data are transmitted from the RTUs through a communications network that could consist of company-owned fiber-optic lines, leased telephone lines, ground- or satellite-based microwave, or radio communication systems.

The SCADA system is monitored 24 hours per day, 365 days a year. SCADA systems allow the pipeline companies to control or shut down portions of a pipeline in the event of an accident or for other safety reasons. They are also used to collect data at different system points as well as to feed data to other administrative function such as billing, marketing, and monitoring cathodic protection systems.

In all SCADA systems, the master terminal unit and RTUs communicate through a defined network of some type. Early systems used wired communications, either through private hard-wired systems owned by the operator (usually practical only for short distances) or through the public-switched phone network. Today there are still many systems using public phone systems, encompassing both wire and fiber optics technology. These facilities allow remote monitoring of the pipeline and communication with valves, compressors, and personnel during operation. Most new systems and many retrofits are using some form of wireless communications. Many pipelines own their own microwave infrastructure, including dedicated towers and radio frequencies.

Systems using frequencies in the very high or ultrahigh frequency (VHF and UHF, respectively) ranges are also in use. These operators may own their own towers or lease space from other operators. Many newer systems are making use of low-power radio transmissions. Satellite communications are also used for long-distance communications.

Task 3. Give the English equivalents for the following Russian words and expressions:

регулирование нагрузки, скорость потока, неисправность оборудования, состояние трубопровода, регулировать скорость потока, в целях безопасности, система катодной защиты, беспроводная связь, диапазон сверхвысокой частоты, передача радиосигналов малой мощности, дистанционный контроль.

Task 4. Answer the questions:

1. What do centralized gas control stations do?
2. Why is there little lag time between taking measurements along the pipeline and transmitting them to the control station?
3. How do pipeline engineers know exactly what is happening along the pipeline at all times?
4. What allows engineers in a centralized control center to adjust flow rates in the pipeline immediately and easily?
5. How are data transmitted from the RTUs?
6. What are the reasons for shutting down portions of a pipeline?
7. What up-to-date facilities allow remote monitoring of the pipeline and communication with valves, compressors, and personnel during the operation?

Task 5. Say whether these sentences are true or false, correct the false ones.

1. Consumers input gas into the pipeline.
2. Sophisticated control systems are required to monitor the gas as it travels through all sections of a potentially very lengthy pipeline network.
3. Most of the data that is received by a control station is provided by RTUs.
4. The data are not transmitted from the RTUs through a communications network.

5. Some forms of wireless communications are also used today.
6. Satellite communications are also used for short-distance communications.
7. Radio communication systems are not used to transmit data from the RTUs.
8. RTUs are placed at intervals along the pipeline.

Text 6. Mackenzie Gas Project

Task 1. Read the following words and word combinations to the text and remember them:
to aid – способствовать.
below freezing – ниже точки замерзания;
chilling – резкое охлаждение;
facility – *зд.* нефтепромысловый объект;
friction – трение**;**
impact – воздействие;
input – данные, полученные сведения;
machinery – техника, оборудование;
permafrost – вечная мерзлота;
to seek – стремиться.

Task 2. Read the text and try to understand it:

Natural gas is moved through a pipeline under pressure. As natural gas flows through a pipeline, it loses pressure due to friction against the inside of the pipe. To keep the natural gas moving at the desired rate, the pressure must be increased. This is accomplished with compressor stations located along a pipeline.

In the proposed Mackenzie Gas Project, after natural gas leaves the Inuvik area facility, it enters the natural gas pipeline. The temperature of the natural gas will slowly decrease in the pipeline, along with the pressure, as it flows south. The temperature decreases due to the pressure reduction. As a result, the natural gas cools. The pressure of the natural gas must be increased along the pipeline through the use of compressor stations. When compressor stations increase the pressure of the natural gas, the temperature of the natural gas rises. The natural gas must be cooled to minimize impacts on the pipeline and permafrost. Two main processes take place at a typical compressor station: gas compression; and gas chilling and cooling. Compressor stations increase or raise the pressure of the natural gas using gas compression machinery that is widely used throughout the oil and gas industry.

The cooling or chilling method used at each compressor station and the station spacing along the pipeline both help to control the temperature. Soil conditions such as ground temperature and water content surrounding the pipe are major factors in determining the required natural gas temperature. If permafrost exists continuously along the pipeline corridor, then the natural gas must be chilled below freezing year-round. Continuous permafrost exists north of Fort Good Hope. Refrigeration is required to achieve this temperature. Where the permafrost is primarily not continuous, the natural gas is cooled to below freezing during the winter. It is also cooled in the warmer months, but remains above freezing. Air coolers and heat exchangers are used to maintain temperatures.

The Mackenzie Gas Project team seeks to improve the design, construction and operation of the compressor stations through public consultation. Information will also be gained from environmental and Traditional Knowledge studies. The combined input will aid in defining the proposed facility locations. Initially four compressor stations will be built as part of the Mackenzie Gas Project.

Task 3. Give the English equivalents for the following Russian words and expressions:

перемещаться под давлением; терять давление из-за трения; при необходимой скорости; наряду с давлением; состояние почвы; содержание воды; основные факторы; требуемая температура природного газа; компрессия газа; сплошная многолетняя мерзлота; воздухоохладитель; теплообменник; исследование окружающей среды; расположение станции.

Task 4. Answer the questions:

1. Why does natural gas lose pressure as it flows through the pipeline?
2. Why must the pressure of the natural gas be increased?
3. Why must the natural gas be cooled?
4. What two main processes take place at a typical compressor station?

5. Where is gas compression machinery widely used?
6. What are the major factors in determining the required natural gas temperature?
7. What kind of equipment is used to maintain temperature of the natural gas?
8. What does the Mackenzie Gas Project team seek to do?

Task 5. Fill in the blanks with the proper words

1. Natural gas flows through a pipeline under … .
a) temperature; b) pressure; c) humidity
2. To keep the natural gas moving at the desired…, the pressure must be increased.
a) temperature; b) direction; c) rate
3. Pressure increase is accomplished with … stations.
a) compressor; b) railway; c) metering
4. The pressure of the natural gas must be … along the pipeline.
a) increased; b) decreased; c) reduced
5. The natural gas must be cooled to minimize … on the pipeline and permafrost.
a) control; b) risks; c) impacts
6. Compressor stations raise the pressure of the natural gas using gas compression…
a) machinery; b) turbines; c) staff
7. The cooling or chilling … is used at each compressor station.
a) access; b) way; c) method
8. Where the permafrost is not continuous, the natural gas is cooled to … freezing during the winter.
a) below; b) above; c) equal
9. To maintain temperatures air coolers and heat … are used.
a) exchangers; b) engines; c) turbines;
10 . Refrigeration is required … below freezing year-round.
a) to transform; b) to heat; c) to chill

Text 7. Compressors

Task 1. Read the following words and word combinations to the text and remember them:
to affix – прикреплять;

anti surge – противопомпажный;
centrifugal – центробежный;
crankshaft – коленчатый вал;
duct – воздуховод;
emission – выброс;
to entrain – захватывать;
gap – зазор;
impeller – рабочее колесо;
inboard – встроенный;
leaking, leakage – утечка;
packing system – уплотнение поршневых штоков;
piston rod – шток поршня;
reciprocating compressor – поршневой компрессор;
seal – уплотнение;
setpoint – заданная величина;
speed setting – настройка оборотов/скорости;
spring – пружина;
suction manifold – впускной манифольд;
supply chain – логистическая цепочка, канал поставок;
surge – помпаж, значительное колебание, скачок, резкий перепад;
surge control valve – противопомпажный регулятор;
wet seal – гидроизоляция

Task 2. Read the text and try to understand it:

Compressors are mechanical devices that increase the pressure of natural gas and allow the natural gas to be transported from the production site, through the supply chain, and to the consumer. Several types of compressors are used for gas compression, each with different characteristics such as operating power, speed, pressure and volume.

Reciprocating Compressors

In a reciprocating compressor, natural gas enters the suction manifold, and then flows into a compression cylinder where it is compressed by a piston driven in a reciprocating motion by the crankshaft powered by an internal combustion engine. Emissions occur when natural gas leaks around the piston rod when pressurized natural gas is in the cylinder. The compressor rod packing system consists of a series of flexible rings that create a seal around the piston rod to prevent gas from escaping between the rod and the inboard cylinder head. However, over time, during operation of the compressor, the rings become worn and the packaging system needs to be replaced to prevent excessive leaking from the compression cylinder.

Centrifugal Compressors

Centrifugal compressors use a rotating disk or impeller to increase the velocity of the natural gas where it is directed to a divergent duct section that converts the velocity energy to pressure energy. These compressors are primarily used for continuous, stationary transport of natural gas in the processing and transmission systems. Many centrifugal compressors use wet (meaning oil) seals around the rotating shaft to prevent natural gas from escaping where the compressor shaft exits the compressor casing. The wet seals use oil which is circulated at high pressure to form a barrier against compressed natural gas leakage. The circulated oil entrains and adsorbs some compressed natural gas that may be released to the atmosphere during the seal oil recirculation process.

Alternatively, dry seals can be used in place of wet seals in centrifugal compressors. Dry seals prevent leakage by using the opposing force created by hydrodynamic grooves and springs. The hydrodynamic grooves are etched into the surface of the rotating ring affixed to the compressor shaft. When the compressor is not rotating, the stationary ring in the seal housing is pressed against the rotating ring by springs. When the compressor shaft rotates at high speed, compressed natural gas has only one pathway to leak down the shaft, and that is between the rotating and stationary rings. This natural gas is pumped between the grooves in the rotating and stationary rings. The opposing force of high-pressure natural gas pumped between the rings and springs trying to push the rings together creates a very thin gap between the rings through which little natural gas can leak. While the compressor is operating, the rings are not in contact with each other and, therefore, do not wear or need lubrication.

The object of the compressor performance control is to keep the operating point close to the optimal setpoint without violating the constraints, by means of control outputs, such as the speed setting. However gas turbine speed control response is relatively slow and even electrical motors are not fast enough since the surge response must be in the 100 mS range. The anti surge control will protect the compressor from going into surge by operating the surge control valve. The basic strategy is to use distance between operating point and surge line to control the valve with a slower response time starting at the surge control line. Crossing the surge trip line will control a fast response opening of the surge valve to protect the compressor.

Task 3. Find English equivalents for the following Russian words and expressions:

эксплуатационная мощность, преобразовать кинетическую энергию в энергию давления, уплотнительное масло; сухое уплотнение; контроль на выходе; потери энергии; антипомпажное регулирование; не нарушая ограничительных условий; реакция на управление/воздействие; время срабатывания/реакции; линия регулирования помпажа.

Task 4. Answer the questions:

1. What are compressors intended for?
2. What types of compressors do you know?
3. How does gas compression occur in a compression cylinder of a reciprocating compressor?
4. When do emissions of natural gas take place?
5. Why does the packaging system need to be replaced?
6. What are centrifugal compressors primarily used for?
7. Can dry seals be used instead of wet seals in centrifugal compressors?
8. What is the object of the compressor performance control?
9. What does the anti surge control protect the compressor from?

Task 5. Fill in the blanks with the proper words.

1. In a reciprocating compressor natural gas is compressed by __________ driven in a reciprocating motion by the crankshaft.
2. There are several types of compressors possessing different _______ such as operating power, speed, pressure and volume.
3. The compressor rod packing system consists of a number of _______ that create a seal around the piston rod.
4. Centrifugal compressors use __________ to increase the velocity of the natural gas.
5. Wet seals use oil which is circulated at high pressure to form _______ against compressed natural gas leakage.
6. Dry seals prevent leakage by using __________ created by hydrodynamic grooves and springs.

7. The opposing force of high-pressure natural gas pumped between the rings and springs creates a very thin _______ between the rings.

Text 8. Metering and Storage Facilities

Task 1. Read the following words and word combinations to the text and remember them:

Custody Transfer Metering Station – узел учета нефтепродуктов.
hull – корпус платформы;
to impede – задерживать, препятствовать;
invoicing – выставление счета;
jetty – причал;
meter – измерительный прибор, расходомер;
metering station – узел учета нефти;
meter run – измерительный участок
minute – незначительный;
to offload – выгружать;
pig – диагностическое и очистное устройство;
production tax – налог на эксплуатацию недр;
prover loop – контрольный контур;
shuttle tanker – челночный танкер;
single point mooring – точечный способ швартовки крупнотоннажных судов;
tank farm – резервуарный парк

Task 2. Read the text and try to understand it:

Most plants do not allow local gas storage, but oil is often stored before loading on a vessel, such as a shuttle tanker taking the oil to a larger tanker terminal, or direct to crude carrier. Offshore production facilities without a direct pipeline connection generally rely on crude storage in the base or hull, to allow a shuttle tanker to offload about once a week. A larger production complex generally has an associated tank farm terminal allowing the storage of different grades of crude to take up changes in demand, delays in transport etc.

Metering stations allow operators to monitor and manage the natural gas and oil exported from the production installation. These metering stations employ specialized meters to measure the natural gas or oil as it flows through the pipeline, without impeding its movement.

This metered volume represents a transfer of ownership from a producer to a customer (or another division within the company) and is therefore called Custody Transfer Metering Station. It forms the basis for invoicing sold product and also for production taxes and revenue sharing between partners and accuracy requirements are often set by governmental authorities.

Typically the metering installation consists of a number of meter runs so that one meter will not have to handle the full capacity range, and associated prover loops so that the meter accuracy can be tested and calibrated at regular intervals. Pipelines can measure anywhere from 6 to 48 inches in diameter. In order to ensure the efficient and safe operation of the pipelines, operators routinely inspect their pipelines for corrosion and defects. This is done through the use of sophisticated pieces of equipment known as pigs.

Pigs are intelligent robotic devices that are propelled down pipelines to evaluate the interior of the pipe. Pigs can test pipe thickness, and roundness, check for signs of corrosion, detect minute leaks, and any other defect along the interior of the pipeline that may either impede the flow of gas, or pose a potential safety risk for the operation of the pipeline. Sending a pig down a pipeline is fittingly known as 'pigging' the pipeline.

The export facility must contain equipment to safely insert and retrieve pigs from the pipeline as well as depressurization, referred to as pig launchers and pig receivers. Loading on tankers involve loading systems, ranging from tanker jetties to sophisticated single point mooring and loading systems that allow the tanker to dock and load product even in bad weather.

Task 3. Find English equivalents for the following Russian words and expressions:

перед погрузкой на судно; танкерный причал; добыча из морских месторождений; специальные расходомеры; работать на полную мощность; требования к точности; интеллектуальные роботизированные устройства; продвигаться по трубопроводу; оценить внутреннее состояние трубопровода; внутренняя очистка трубопровода; безопасно вставлять и извлекать диагностическое и очистное устройство; сброс давления; причал для танкера; устройство запуска очистных устройств; устройство приема очистных устройств.

Task 4. Answer the questions:

1. What do metering stations allow operators to do?
2. What are specialized meters applied for?
3. What does a typical metering installation consist of?
4. What is the reason for inspecting pipelines for corrosion and defects?
5. What type of equipment are pigs?
6. What kind of work can pigs do?
7. What equipment must the export facility contain?

Task 5. Fill in the blanks with the proper words.

1. A larger production complex generally has an associated tank farm terminal allowing the storage of different ________ of crude oil.
2. Metering stations employ __________ meters to measure the natural gas or oil.
3. Custody Transfer Metering forms the basis for ________ sold product.
4. The metering installation consists of a number of ________ and associated prover loops.
5. Inspection of pipelines for corrosion and defects is done with the equipment known as __________.
6. Pigs can detect any defect along the ________ of the pipeline.
7. ________ the pipeline is sending a pig down a pipeline.
8. Loading on tankers involve loading systems allowing ________ to dock and load product even in bad weather.

Text 9. Metering

Task 1. Read the following words and word combinations to the text and remember them:

analyzer – прибор для обработки результатов испытаний;
custody transfer – передача продукта потребителю;
dipstick – мерная рейка;
energy value – теплота сгорания;
flare gas – факельный газ;
injected gas – нагнетаемый в скважину газ.
LNG (liquefied natural gas) – сжиженный природный газ;
manual records – ручной режим записи;

mass flow – массовый расход;
meter factor – коэффициент пересчета измерительного прибора;
orifice meter – диафрагменный расходомер;
orifice plate – измерительная диафрагма расходомера;
positive displacement meter – расходомер объемного типа;
pressure differential – перепад давления;
prover ball – шарик калибратора;
residue – осадок

Task 2. Read the text and try to understand it:

Partners, authorities and customers all calculate invoices, taxes and payments based on the actual product shipped out. Often custody transfer also takes place at this point, it means a transfer of responsibility from the producer to a customer, shuttle tanker operator or pipeline operator.

Although some small installations are still operated with dipstick and manual records, larger installations have analysis and metering equipment. To make sure readings are accurate, a fixed or movable prover loop for calibration is also installed.

The analyzer instruments provide product data such as density, viscosity and water content. Pressure and temperature compensation is also included.

For liquid, turbine meters with dual pulse outputs are most common. Alternatives are positive displacement meters (passes a fixed volume per rotation or stroke) and Coriolis mass flow meters. These instruments cannot cover the full range with sufficient accuracy. Therefore the metering is split into several runs, and the number of runs in use depends on the flow. Each run employs one meter and several instruments to provide temperature and pressure correction. Open/Close valves allow runs to be selected and control valves can balance the flow between runs. The instruments and actuators are monitored and controlled by a flow computer. If the Interface is not digital, dual pulse trains are used to allow direction sensing and fault finding.

To obtain required accuracy, the meters are calibrated. The most common method is a prover loop. A prover ball moves though the loop, and a calibrated volume is provided between the two detectors. When a meter is to be calibrated the four way valve opens to allow oil to flow behind the ball. The number of pulses from it passes one detector to the other is counted. After one loop the four-way valve turns to reverse flow direction and the ball moves back providing the same volume and in reverse, again counting the pulses. From the known reference volume, number of pulses, pressure and temperature the flow computer can calculate the meter factor and provide accurate flow measurements using formulas from industry standard organizations such as API MPMS and ISO 5024. The accuracy is typically ± 0.3% of standard volume.

Gas metering is similar, but instead, analyzers will measure hydrocarbon content and energy value (MJ/scm or BTU, Kcal/scf) as well as pressure and temperature.

The meters are normally orifice meters or ultrasonic meters. Orifice plates with a diameter less than the pipe are mounted in cassettes. The pressure differential over the orifice plate as well as pressure and temperature is used in standard formulas (such as AGA 3 and ISO 5024/5167) to calculate normalized flow. Different ranges are accommodated with different size restrictions. Orifice plates are sensitive to build up of residue and wear on the edges of the hole. Larger new installations therefore prefer ultrasonic gas meters that work by sending multiple ultrasonic beams across the path and measure the Doppler Effect.

Gas metering is less accurate than liquid, typically ±1.0% of mass. There is usually not a prover loop, instead the instruments and orifice plates are calibrated in separate equipment.

LNG is often metered with mass-flow meters that can operate at the required low temperature.

At various points in the movement of oil and gas, similar measurements are taken, usually in a more simplified variant. Examples are Flare gas, Fuel Gas and Injected gas where required accuracy is 2-5% percent.

Notes:

API MPMS – American Petroleum Institute's Manual of Petroleum Measurement Standards – Сборник стандартов по измерениям в нефтяной промышленности Американского Нефтяного Института;
ISO – International Organization for Standardization **–** Международная организация по стандартизации;
BTU, Btu – British thermal unit – британская тепловая единица (0,252 ккал);
AGA – American Gas Association – газовая ассоциация США.

Task 3. Find English equivalents for the following Russian

words and expressions:
двухимпульсные выходные сигналы; расходомер Кориолиса; полный диапазон; разделяться на несколько участков; клапан двухпозиционного действия «открытие-закрытие»; определение направления перемещения; обнаружение неисправности; четырехходовой клапан; референтный объем; количество импульсов; поточный компьютер; ультразвуковой расходомер; эффект Допплера; ультразвуковой луч; нормированный поток; менее точный; требуемая точность.

Task 4. Answer the questions:

1. What equipment is usually installed to provide accurate readings?
2. What kind of data do the analyzer instruments provide?
3. Why is the metering split into several runs? What does the number of runs depend on?
4. What equipment monitors and controls instruments and actuators?
5. How can flow computer calculate the meter factor and provide accurate flow measurements?
6. What can gas analyzers measure?
7. What is used in standard formulas to calculate the normalized flow?
8. What are orifice plates sensitive to?
9. Is gas metering more accurate or less accurate than liquid metering?
10. What kind of equipment do larger new installations prefer?

Task 5. Fill in the blanks with the proper words.

1. Partners and customers calculate invoices, taxes and payments based on the _____ product shipped out.
a) virtual; b) actual; c) basic

2. __________ with dual pulse outputs are most common for liquid.
a) Turbine meters; b) Altitude meters; c) Activity meters

3. Control valves can ___________ the flow between runs.
a) compare;b) balance; c) direct

4. To obtain the required accuracy, the meters are __________.
a) refined; b) improved; c) calibrated

5. Orifice plates are ______ to build up of residue and wear on the edges of the hole.
a) sensitive; b) indifferent; c) active

6. In gas metering the instruments and orifice plates are calibrated _________.
a) inside a pipeline; b) in separate equipment; c) in the field

7. Liquefied natural gas is often metered with ________ meters.
a) leakage; b) power; c) mass-flow

Task 6. Say whether these sentences are true or false, correct the false ones.

1. Custody transfer is a transfer of responsibility from the customer to a producer.
2. Some small installations are still operated with dipstick and manual records
3. The analyzer instruments provide such product data as light, brightness and shape.
4. Alternatives for turbine meters with dual pulse outputs are positive displacement meters and Coriolis mass-flow meters.
5. In some cases dual pulse trains are used to allow direction sensing and fault finding.
6. The least common method of calibration is a prover loop.
7. When a meter is to be calibrated the four-way valve opens to allow oil to flow before the ball.
8. Gas metering is less accurate than liquid metering.
9. At various points in the movement of oil and gas, quite different measurements are taken.
10. In gas metering analyzers measure hydrocarbon content and energy value as well as pressure and temperature.

Text 10. Flow Meters

Task 1. Read the following words and word combinations to the text and remember them:

to amplify – усилить;
bend – изгиб, колено (трубопровода);

caused by – *зд.* под воздействием;
to differentiate – отличаться, видоизменяться.
flow meter – счетчик-расходомер;
maintenance – техническое обслуживание и ремонт;
medium – среда, вещество**;**
mode of operation – режим работы;
to promote – содействовать, способствовать;
sensor coil – сенсорная обмотка;
shift – сдвиг;
transducer – преобразователь;
volume flow – объемный расход

Task 2. Read the text and try to understand it:

Ultrasonic Flow Meters The ultrasonic flow meters are based on the difference in transit time method. Each couple of transducers (channel), built in the opposite side of the measuring tube, send and receive acoustic signals through the flow in two opposite directions. One signal is sent downstream of the flow and one is sent upstream, both along the same path. A sound wave travels faster with the flow than one against the flow. The difference in transit times is proportional to the medium's flow velocity. The number, shape and location of the channels, are the key to compensating for flow profile effects. The major difference is due to the centre beam which reliably differentiates between turbulent and laminar flow.

Coriolis Mass Flow Meters The mode of operation of mass flow meter is based on the Coriolis principle. This allows you to determine the mass flow of liquids and gases from the deformation of the measuring pipe caused by liquids and gases. At the same time, the density of the medium can be taken from the resonance frequency of the pipe that has been caused to vibrate. Two sensor coils serve to detect the Coriolis effect. If there is no flow, both sensors record the same sinusoidal signal. Once a flow begins, the Coriolis force acts on the flowing mass particles of the medium and leads to a deformation of the measuring pipe and a phase shift between the sensor signals. The sensors measure the phase shift of the sinusoidal vibrations. This phase shift is directly proportional to the mass flow. Volume flow is calculated from mass and density measurement. The straight-tube flow meters ensure minimum pressure drop and minimum effects of bends in the measuring tube.

Electromagnetic Flow Meters The electromagnetic flow meter is based on Faraday's law of induction. According to this law, a certain voltage is induced in a conductor or conductive medium, which is moving in a magnetic field. This voltage is proportional to the movement speed of the medium. For electromagnetic flow meters, the induced voltage is tapped either via two measuring electrodes that are in conductive contact with the measure substance or in a capacitive manner with no contact. An electronic measuring transducer amplifies the signal and converts it to a standard signal. First introduced, the electromagnetic flow meter has been continuously developed ever since. The use of non-mechanical devices is being promoted to reduce maintenance and improve reliability.

Task 3. Find English equivalents for the following Russian words and expressions:
профиль потока; звуковая волна; посылать и принимать акустический сигнал; вдоль одного канала (траектории); время прохождения; турбулентный и ламинарный поток; массовый расходомер; частота резонанса; синусоидальный сигнал; сила Кориолиса; падение давления; закон Фарадея; проводящий контакт.

Task 4. Answer the questions:

1. What principle are the ultrasonic flow meters based on?
2. Does a sound wave travel faster with the flow or against the flow?
3. What is the mode of operation of the Coriolis mass flow meter based on?
4. What does the Coriolos principle allow us to determine?
5. What do the straight-tube flow meters ensure?
6. What is the electromagnetic flow meter based on?
7. Why is the use of non-mechanical devices being promoted?

Task 5. Say whether these sentences are true or false, correct the false ones.

1. Both signals in the ultrasonic flow meters are sent downstream along different paths.
2. In the ultrasonic flow meters, the number, shape and location of the channels are the key to compensating for flow profile effects.
3. The density of the medium serves to detect the Coriolis effect.
4. The Coriolis force acts on the flowing mass particles of the medium

and leads to a deformation of the measuring pipe and a phase shift between the sensor signals.
5. The phase shift of the sinusoidal vibrations is inversely proportional to the mass flow.
6. According to Faraday's law, a certain voltage is induced in a conductor or conductive medium, which is moving in a magnetic field.
7. An electronic measuring transducer weakens the signal and converts it to a standard signal.

Task 6. Match the synonymous words in two columns.

1. path	a. motion
2. speed	b. impact
3. tube	c. to intensify
4. to detect	d. way
5. drop	e. velocity
6. effect	f. to move
7. movement	g. to define
8. to result in	h. pipe
9. to amplify	i. to lead to
10. to travel	j. decrease

Text 11.

Task 1. Read the text below and name it

Plate heat exchangers ensure low energy input, gentle product handling and an efficient process. With GEA plate heat exchangers up to 96 % of the energy used in the process can be recovered. To achieve this all materials and components must be exactly matched to each other. And this demands not only competence in heat transfer, but also an exact knowledge of the processes. GEA has been an expert in the field of heat transfer for decades and is a pioneering force in plate heat exchanger development.

The Competence and Service Center for gasketed, fully welded and brazed plate heat exchangers obtains the optimum performance from every process. To achieve this, GEA supplies the complete range of gasketed, fully-welded and brazed units. And this pioneering spirit is being strengthened with the integration into the GEA Heat Exchangers

Segment of the GEA Group. Every day a wealth of expertise and experience is processed and made available to all companies within the group, resulting in valuable innovations.

Every single one of our products utilizes the latest, combined process know-how and project expertise from all heat exchanger technologies. Developed in Germany and produced in a worldwide network of modern manufacturing facilities our plate heat exchangers (PHEs) are individually tailored for heat exchanging processes: the size of their heat exchanger surfaces, the selection of the plate materials, their surface profiles and flow control properties, the wide range of gaskets and connection variants create an almost unlimited modular system for tailor-made heat exchanger solutions, offering problem-free upgrading or downsizing.

Task 2. What type of text is it?

a) academic conference paper;
b) newspaper article;
c) advertising article;
d) science fiction.

Task 3. Tell the classmates about the equipment described in the text above.

Supplementary Reading

Read the texts and discuss them with the students in your group.

Text 1. A Brief History of Automatic Control

by Stuart Bennett

Automatic feedback control systems have been known and used for more than 2000 years; some of the earliest examples are water clocks described by Vitruvius and attributed to Ktesibios (circa 270 B.C.). Some three hundred years later, Heron of Alexandria described a range of automata which employed a variety of feedback mechanisms. The word "feedback" is a 20th century neologism introduced in the 1920s by radio engineers to describe parasitic, positive feeding back of the signal from the output of an amplifier to the input circuit. It has entered into common usage in the English-speaking world during the latter half of the century.

The history of automatic control divides conveniently into four main periods as follows:

- Early Control: To 1900
- The Pre-Classical Period: 1900-1940
- The Classical Period: 1935-1960
- Modern Control: Post-1955

Early Control: To 1900

Knowledge of the control systems of the Hellenic period was preserved within the Islamic culture that was rediscovered in the West toward the end of the Renaissance. New inventions and

applications of old principles began to appear during the 18th century-for example, Rene-Antoine Ferchault de Reamur (1683-1757) proposed several automatic devices for controlling the temperature of incubators. These were based on an invention of Cornelius Drebbel (1572-1663). The temperature was measured by the expansion of a liquid held in a vessel connected to the U-tube containing mercury. A float in the mercury operated device which, through a mechanical linkage, controlled the draft to a furnace and hence the rate of combustion and heat output.

The most significant control development during the 18th century was the steam engine governor. The origins of this device lie in the lift tenter mechanism which was used to control the gap between the grinding-stones in both wind and water mills.

Most of the inventions and applications of this period were concerned with the basic activities of controlling temperatures, pressures, liquid levels, and the speed of rotating machinery: the desire was for regulation and for stability. However, growth in the size of ships and naval guns, and introduction of new weapons such as torpedoes, resulted in the application of steam, hydraulic, and pneumatic power systems to operate position control mechanisms. In the United States, Britain, and France, engineers began to work on devising powered steering engines to assist the helmsman; on large ships the hydrodynamic forces on the rudder were such that large gear ratios between the helm and the rudder were required and hence moving the rudder took a long time. The first of powered steering engine, designed by Frederick Sickels in the U.S. (patented 1853) was an open-loop system.

Further applications for control systems became apparent with the growth in knowledge of electricity and its applications. For example, ill C lamps required the gap between the electrodes to be kept constant, and generally it was helpful to all users if either the voltage or the current of the electricity supply was kept constant. Electricity also provided additional tools for measurement, for transmission and manipulation of signals, and for actuation which engineers began to use. The electric relay, which provided high gain power amplification, and the spring biased solenoid, which provided (crude) proportional control action, were significant devices.

The Pre-Classical Period (1900-1935)

The early years of the 20th century saw the rapid and widespread application of feedback controllers for voltage, current, and frequency regulation; boiler control for steam generation; electric motor speed control; ship and aircraft steering and auto stabilization: and temperature, pressure, and flow control in the process industries. In the twenty years between 1909 and 1929, sales of instruments grew rapidly as Fig. 1 shows. The majority of the instruments sold were measuring, indicating, and recording devices, but toward the end of the period the sales of controllers began to increase. The range of devices designed, built, and manufactured was large; however, most were designed without any clear understanding of the dynamics both of the system to be controlled and of the measuring and actuating devices used for control.

The Classical Period: 1935-1950

During the period 1935-1940, advances in understanding of control system analysis and design were made independently by several groups in several countries. The best known and most

influential work came from three groups working in the U.S. The development in Europe and in Russia during this period followed a somewhat different path deriving from Vyschnegradsky's work in Russia and then Barkhausen's work in Germany, followed by developments due to Cremer, Leonhard, and Mikhailov.

The wartime experience demonstrated the power of the frequency response approach to the design of feedback systems; it also revealed the weakness of any design method based on the assumption of linear, deterministic behavior. Real systems are non-linear; real measurements contain errors and are contaminated by noise; and in real systems both the process and the environment are uncertain.

Work on developing frequency response ideas and design methods continued throughout the 1950s. Design methods for systems containing nonlinearities were developed, as were the theoretical foundations of sampled-data systems. The teaching of servomechanisms and control theory spread, initially through special courses run for practicing engineers and graduate students and then through incorporation within the standard syllabus of many engineering courses.

Modern Control

Although the direction of some post -war work was influenced by the insights and new understandings developed during the war, the trajectory of development, Alistair J.G. MacFarlane (1979) argues, was largely determined by two factors: first, the problem that governments saw as important for the launching, maneuvering, guidance, and tracking of missiles and space vehicles; and second, by the advent of the digital computer. The first problem was essentially control of ballistic objects, and hence detailed physical models could be constructed in terms of differential equations, both linear and non-linear; also measuring instruments and other components of great accuracy and precision could be developed and used. Engineers working in the aerospace industries, following the example set by Poincare, turned to formulating the general differential equations in terms of a set of first-order equations, and thus began the approach that became known as the "state-space" approach.

Text 2. What is Artificial Intelligence?

by John McCarthy

Artificial Intelligence is "the scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines." It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

Artificial intelligence (AI)is a branch of computer science that studies the computational requirements for tasks such as perception, reasoning, and learning, and develops systems to perform those tasks. AI is a diverse field whose researchers address a wide range of problems, use a variety of methods, and pursue a spectrum of scientific goals. For example, some researchers study the requirements for expert performance at specialized tasks, while others model commonsense processes; some researchers explain behaviors in terms of low-level processes, using models inspired by the computation of the brain, while others explain them in terms of higher-level psychological constructs such as plans and goals. Some researchers aim to advance understanding of human cognition, some to understand the requirements for intelligence in general (whether in humans or machines), and some to develop artifacts such as intelligent devices, autonomous agents, and systems that cooperate with people to amplify human abilities.

AI is a young field–even its name, "artificial intelligence," was only coined in 1956. One of the challenges for AI has been to determine which tasks to study–what constitutes an "AI question"–and how to evaluate progress. Much early AI research focused on tasks commonly thought to require high intelligence in people, such as playing high-quality chess. Skeptics viewed this as an impossible assignment, but AI made rapid progress. By the 1960's, programs were capable of tournament play. In 1997, in a landmark match, the chess system Deep Blue defeated Gary Kasparov, the world's human chess champion for the previous twelve years. At the same time, however, AI research was illuminating the enormous difficulty of commonsense tasks that people take for granted, such as understanding stories or conversations. Developing programs that can deal at a human level with rich everyday reasoning remains a fundamental research challenge.

In the logicist approach to knowledge representation and reasoning, information is encoded as assertions in a logics, and the system draws conclusions by deduction from those assertions. Other research studies non-deductive forms of reasoning, such as reasoning by analogy and abductive inference–the process of inferring the best explanation for a set of facts. Abductive inference does not guarantee sound conclusions, but is enormously useful for tasks such as medical diagnosis, in which a reasoner must hypothesize causes for a set of symptoms.

Capturing the knowledge needed by AI systems has proven to be a challenging task. The knowledge in rule-based expert systems, for example, is represented in the form of rules listing conditions to check for, and conclusions to be drawn if those conditions are satisfied. For example, a rule might state that IF certain conditions hold (e.g., the patient has certain symptoms), THEN certain conclusions should be drawn (e.g., that the patient has a particular condition or disease). A natural way to generate these rules is to interview experts. Unfortunately, the experts may not be able to adequately explain their decisions in a rule-based way, resulting in a "knowledge-acquisition bottleneck" impeding system development.

In its short existence, AI has increased understanding of the nature of intelligence and provided an impressive array of applications in a wide range of areas. It has sharpened understanding of human reasoning, and of the nature of intelligence in general. At the same time, it has revealed the complexity of modeling human reasoning, providing new areas and rich challenges for the future.

Text 3. The Emergence of Modern Control Theory

The *modern* or *state space* approach to control was ultimately derived from original work by Poincare and Lyapunov at the end of the 19th century. As noted above, Russians had continued developments along these lines, particularly during the 1920s and 1930s in centres of excellence in Moscow and Gorkii (now Nizhnii Novgorod). Russian work of the 1930s filtered slowly through to the West, but it was only in the post war period, and particularly with the introduction of cover-to-cover translations of the major Soviet journals, that researchers in the USA and elsewhere became familiar with Soviet work. But phase plane approaches had already been adopted by Western control engineers.

One of the first was *Leroy MacColl* in his early textbook.

The cold war requirements of control engineering centred on the control of ballistic objects for aerospace applications. Detailed and accurate mathematical models, both linear and nonlinear, could be obtained, and the classical techniques of frequency response and root locus – essentially approximations – were increasingly replaced by methods designed to optimize some measure of performance such as minimizing trajectory time or fuel consumption. Higher-order models were expressed as a set of first order equations in terms of the state variables. The state variables allowed for a more sophisticated representation of dynamic behaviour than the classical single-input, single-output system modeled by a differential equation, and were suitable for multivariable problems. In general, we have in matrix form

$\boldsymbol{x} = \mathbf{A}\boldsymbol{x}+\mathbf{B}\boldsymbol{u}$, $\boldsymbol{y} = \mathbf{C}\boldsymbol{x}$, where $\boldsymbol{x}$ are the state variables, $\boldsymbol{u}$ the inputs and $\boldsymbol{y}$ the outputs.

Automatic control developments in the late 1940s and 1950s were greatly assisted by changes in the engineering professional bodies and a series of international conferences. In the USA both the American Society of Mechanical Engineers and the American Institute of Electrical Engineers made various changes to

their structure to reflect the growing importance of servomechanisms and feedback control. In the UK similar changes took place in the British professional bodies, most notably the Institution of Electrical Engineers, but also the Institute of Measurement and Control and the mechanical and chemical engineering bodies. The first conferences on the subject appeared in the late 1940s in London and New York, but the first truly international conference was held in Cranfield, UK in 1951. This was followed by a number of others, the most influential of which was the Heidelberg event of September 1956, organized by the joint control committee of the two major German engineering bodies, the VDE and VDI. The establishment of the International Federation of Automatic Control followed in 1957 with its first conference in Moscow in 1960 [4.48]. The Moscow conference was perhaps most remarkable for Kalman's paper *On the general theory of control systems* which identified the duality between multivariable feedback control and multivariable feedback filtering and which was seminal for the development of optimal control.

The late 1950s and early 1960s saw the publication of a number of other important works on dynamic programming and optimal control, of which can be singled out those by *Bellman*, *Kalman* and *Pontryagin.*

Text 4. What Is a Control Engineer?

by David M. Koenig

So far we have implied that a control engineer designs control algorithms. In fact, the title of control engineer can mean many things. The following list, in no particular order, covers many of these "things":

1) Installer of control! instrumentation equipment (sometimes called an "instrumentation engineer"): In my experience this is the most prevalent description of a control engineer's activities. In this case, the actual design of the control algorithm is usually quite straightforward. The engineer usually purchases an off-the-shelf controller, installs it in an instrumentation panel, probably of her design, and then proceeds to make the controller work and get the process under control. This often is not trivial. There may be control input sensor problems. For example, the input signal may come from a thermocouple in an electrically heated bath of some kind and there may be serious common and normal mode

voltages riding on the millivolt signal representing the thermocouple value. There may be control output actuator problems. There may be challenging process dynamics problems, which require careful controller tuning. In many ways, instrumentation engineering can be the most challenging aspect of control engineering.

2) Control algorithm designer: When off-the-shelf controllers will not do the job, the scene is often set for the control algorithm designer. The vehicle may be a microprocessor with a higher-level language like BASIC or a lower-level language like assembly language. It may even require firmware. Many control/instrumentation engineers fantasize about opportunities like this. They have to be careful to avoid exotic custom undocumented algorithms and keep it simple.

3) Process improvement team member: Although this person is trained in control engineering, success may result from solving process problems rather than installing new control algorithms.

4) Process problem solver: This is just a different name for the previous category although it may be used when the team members have developed a track record of successes.

Text 5. Flow Meters

Gas Ultrasonic Flow Meters: ALTOSONIC V12 / V6 The first of the next generation of ultrasonic custody-transfer flow meters: their unique measurement chord arrangement combined with a dedicated diagnostic chord, achieves a quantum leap in accuracy, independent of installation effects such as bends and swirl. Real-time performance monitoring now makes predictive maintenance a reality. V12 is the first ultrasonic gas flow meter to achieve OIML Accuracy Class 0.5; most others only achieve Class 1.0.

Liquid Ultrasonic Flow Meters: ALTOSONIC V / III The ALTOSONIC V is the most widely used ultrasonic meter for custody transfer of liquid petroleum products. Its unique five beams and continuous Reynolds correction make it essentially independent of viscosity and density over a wide dynamic flow range. It is therefore the ideal meter for crude oil, LPG, and multi-product pipelines. There are special versions available as MasterMeters, for high-viscosity crude, and for LNG.

The ALTOSONIC III, offers a cost effective solution for single petroleum products. Apart from greenfield it is also an ideal replacement for traditional mechanical measurement devices.

Liquid and Gas Coriolis Mass Flow Meter: Optimass

2000 These truly straight twin-tube mass flow meters have been specifically developed for high-volume measurements in the oil and gas industry, such as terminals and transport pipelines. The Optimass 2000 Coriolis mass flow meter is easy to install, has a small footprint, and measures essentially independent of pressure and temperature. It therefore provides accurate, custody-transfer measurement of volume and mass over a wide flow range.

Gas and Wet Gas Venturi Tube: VPE 7600 As part of our meter portfolio, we manufacture a range of venturi flow meters to fulfil our customers needs for this special technology for metering applications such as wet gas.

Electromagnetic Flow Meters These high-pressure meters find use in well-water injection, produce water, as well as flow metering applications in refineries. They are available in various sizes, materials and liners to cover all needs. Auxiliary Metering Products for the Oil & Gas industry Custody Transfer Flow Meters

Radar Level Meters These devices have an accuracy of up to ±1 mm (Custody Transfer OIML R 85) thanks to FMCW & PLL radar technology. The horn antenna has a stay-clean design, purging system, and no moving parts. 4-Wire or 2-wire loop-powered technology make installation flexible. Communication is via HART, RS485, Profibus and FF serial outputs. Also available as TDR contact version with rod and cable antennas and heavy-duty marine version.

References

1. C.C. Bissell, A History of Automatic Control/ https://www.control.lth.se/fileadmin
2. Stuart Bennett, A Brief History of Automatic Control; **edis-ciplinas.usp.br**›pluginfile.php/1500802/mod_...
3. John McCarthy, What is Artificial Intelligence?; **http://jmc.stanford.edu**›articles/whatisai/whatisai.pdf
4. David M. Koenig, What Is a Control Engineer?; **ebook-hunter.org**›practical-control-engineering-by...