МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
«САМАРСКИЙ НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ ИМЕНИ АКАДЕМИКА С. П. КОРОЛЕВА»
(САМАРСКИЙ УНИВЕРСИТЕТ)

С.А. ЛУЦЕНКО

ЭЛЕКТРОНИКА: ПЕРСПЕКТИВЫ РАЗВИТИЯ

(ELECTRONICS: PROSPECTS FOR EVOLUTION)

Рекомендовано редакционно-издательским советом федерального государственного автономного образовательного учреждения высшего образования «Самарский национальный исследовательский университет имени академика С. П. Королева» в качестве учебного пособия для студентов, обучающихся по основной образовательной программе высшего образования по направлению подготовки 11.03.01 Радиотехника

САМАРА
Издательство Самарского университета
2018

УДК 42 (075) + 621.38(075)
ББК 81.2я7 + 32.85я7
Л869

Рецензенты: доц. кафедры иностранных языков и РКИ
Самарского университета Н. Г. С т е п н о в а,
канд. филол. наук, доц. кафедры «Лингвистика»
СамГУПС М. А. Т е р п а к

Луценко, Светлана Александровна
Л869 **Электроника: перспективы развития (Electronics: Prospects for Evolution):** учеб. пособие / *С.А. Луценко*. – Самара: Изд-во Самарского университета, 2018. – 160 с.

ISBN 978-5-7883-1282-8

Целью учебного пособия является дальнейшее развитие и совершенствование навыков чтения, устной и письменной речи на основе материалов, соответствующих направлениям подготовки факультета электроники. Аутентичный текстовый материал способствует совершенствованию навыков по основным видам чтения. Основной текст раздела предназначен для изучающего чтения, дополнительные тексты предполагают просмотровое и поисковое чтение. Тексты сопровождаются системой упражнений, направленных на усвоение специальной лексики и терминологии, развитие умения аннотирования, анализа и обобщения информации. С целью повторения сложных грамматических явлений и структур разделы включают грамматический справочник по изучаемым явлениям и обширную систему практических упражнений.

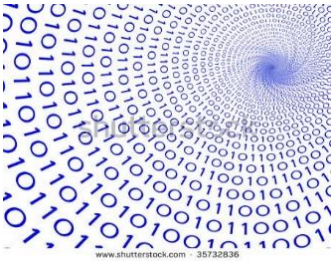
Составлено в соответствии с требованиями программы по иностранному языку для неязыковых вузов и программы “English for Special Purposes”. Предназначено для студентов, обучающихся по направлению подготовки 11.03.01 Радиотехника.

УДК 42 (075) + 621.38(075)
ББК 81.2я7 + 32.85я7

ISBN 978-5-7883-1282-8

UNIT 1 Digital Data Transmission

Lead-in



1. What data transmission technologies do you know? Read the passage below to check your ideas.

Data transmission is the process of sending data over a communication medium to one or more computing networks, communication or electronic devices. It enables data transfer in a point-to-point, point-to-multipoint and multipoint-to-multipoint environment.

Data transmission can be analog and digital. Communication systems based on analog signals dominated the first half of the 20th century. Starting in the early 1950s, however, the widespread availability of digital computers led to a digital revolution, which is now well under way. The technology ranges from popular gadgets to the sophisticated data-handling techniques of the synchronous satellites used in worldwide communications.

2. Work in pairs and discuss the following questions.

1. Which technique - analog or digital - is more efficient, provides data transmission of a better quality?

2. Which transmission system is most likely to become the technology of the future?

3. What electronic gadgets would you prefer – analog or digital? Why?

Think of as many arguments as possible to support your point of view.

3. Compare your views with those of other students. Do your opinions coincide or contradict?

4. Summarize your ideas and make a list of the most essential features and advantages of digital systems (consider amounts of data to be transferred, the speed of transmission, a number of data channel required for transmission, the quality of a signal, noise immunity, etc.).

Vocabulary

1. Data transmission involves a set of special words and concepts. Some basic terms are given below. Match them up with the definitions on the right.

1. multiplex	**A**. A telephone line or channel between two main offices or switching devices.
2. a loop	**B.** The amount of detail that can be distinguished in an image, the degree of image sharpness measured by the number of pixels across and down on a screen.
3. an increment	**C.** The use of a common communications channel for sending two or more messages or signals.
4. frequency-division multiplexing	**D.** A distance that an object travels or is transported.
5. a trunk	**E.** A method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern.
6. haul	**F.** A closed electric or magnetic circuit through which a signal can circulate or current flows.
7. time-division multiplexing	**G.** The process of increasing in number, size, quantity, or extent.

8. resolution	**H.** A technique by which the total bandwidth available in a communication medium is divided into a series of non-overlapping frequency sub-bands and each one is used to carry a separate signal.

2. Use the words from the box to complete the passage below.

continuous bit streams distortion amplitude multiplexers discrete communication medium networking binary format data exchange

Analog and digital signals are used to transmit information. In both technologies the information, either audio or video, is transformed into electric signals. The difference between analog and digital technologies is that in analog technology information is converted into electric pulses of varying 1) _____ whereas, in digital technology, data is transformed into 2) _____ (zero or one) where each bit represents two distinct amplitudes.

An analog signal is any 3) _____ signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity, i.e. analogous to another time varying signal.

A digital signal uses 4) _____ (discontinuous) values. The digital data originates from the source device in the form of discrete signals or digital 5) _____. These data streams are placed over a 6) _____, such as copper wires, wireless carriers or optical fiber, for delivery to the destination device.

Transmission of digital signals is fixed in terms of amplitude. Transmitted data remains protected since the signals have more balanced structure. Analog signals, on the other hand, do not have any defined level of uniformity and controllability in terms of amplitude. As a result, these signals are more susceptible to 7) _____. This

drawback significantly reduces the signal transmission for long distances. Moreover, these signals can be easily intervened and disturbed.

Digital signals are indispensable when information has to be sent for longer distance or the data is so significant that cannot be lost. In the field of communication, digital signals are used in cellular communications, internet 8) _____, high 9) _____ modes such as 3G, Bluetooth. In electronics, digital signals are applied in designing new codes for computer and mobile circuitry. Devices such as 10) _____, digital gates and other combinational and sequential circuit designs are some of the widespread applications of digital technology.

Reading

1. The following article is about the advantages of digital data transmission and networks. Read the article and highlight the arguments in favour of digital technology.

Digital Technology Benefits

The advent of digital electronic circuitry has brought revolutionary changes in the area of communication and industrial instrumentation. From early applications of digital computers in the 1960s to the first distributed control systems (DCS) in the 1970s and the "smart" transmitter revolution of the 1980s, digital technology has improved performance and expanded information-sharing capabilities of communications systems, measuring and control instruments.

One of the greatest advantages of digital technology over analog is the ability to communicate vast amounts of data over a limited number of data channels. In the world of 4-20 mA signaling each pair of wires can communicate only one variable. This one-signal-per-channel limit of 4-20 mA analog signals represents a technological "bottleneck" restricting data transfer between instruments and control systems. The data-rich capabilities of industrial instrumentation require a digital form of communication to overcome the drawback of analog 4-20 mA signals. With digital signaling, a single pair of wires or coaxial cable is able to convey a theoretically unlimited number of data points. This benefit comes at a price, though: in order to transfer multiple variables

over a single channel (wire pair), we must transmit and receive those signals one at a time. This means a digital communications system will necessarily exhibit some degree of time delay in acquiring, transmitting, receiving, and interpreting a signal. Analog systems, by contrast, are virtually instantaneous.

With modern electronic technology, it is possible to create fast digital communication systems so that the time delays are negligible for most industrial processes, which renders the comparison- instantaneous versus time-delayed- insignificant. If time is no longer an issue, the advantage that digital communication has over analog in terms of channel usage makes it the superior choice. Another important advantage of digital data communication for industrial processes is increased noise immunity. Analog data is continuous by nature: a signal of 11.035 milliamps has a different meaning than a signal of 11.036 milliamps, because any measurable increment in signal represents a corresponding increment in the physical variable expressed by that signal. A voltage value in a 0-5 volt digital signaling system of 0.03 volts, however, means exactly the same thing as a voltage value of 0.04 volts: either one is interpreted as a "0" or "low" state. Any amount of electrical noise imposed on an analog signal corrupts the signal to some degree. A digital signal, on the contrary, may tolerate a substantial amount of electrical noise with no noticeable corruption.

Not surprisingly, though, the noise immunity enjoyed by digital signals comes with a price: a sacrifice in resolution. Analog signals are able to represent the smallest imaginable changes because they are continuously variable. Digital signals are limited in resolution by the number of bits in each data "word".

With modern digital electronic technology, however, the "limited resolution" problem is of no importance. 16-bit converter chipsets available for input/output modules on digital systems provide a resolution, which is good enough for the vast majority of industrial measurement and control applications.

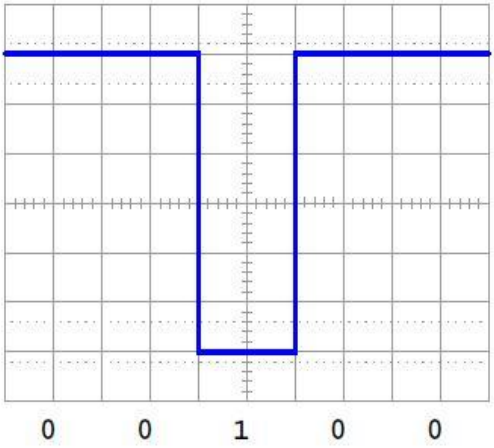
There are two techniques used for data transmission: serial and parallel. Serial transmission is the most applicable for industrial applications because for parallel transmission the number of wires matches the

number of bits in each data "word". Thus, parallel technique eliminates the "fewer wires" advantage of digital communications and is rarely used in industry. In serial communications systems, digital data is sent over a wire pair (or fiber optic cable, or radio channel) one bit at a time.

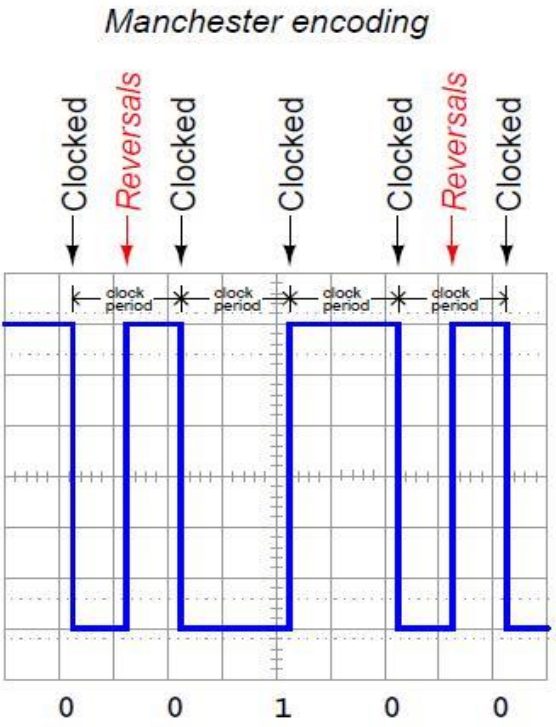
To transfer digital data along a network, there must be an agreed standard between transmitting and receiving devices for encoding bits. A range of encoding methods are available, NRZ, Manchester, FSK being the most suitable for industrial networks.

Digital communication standards represent binary "1" value as a "mark" state and "0" as a "space" state. "Marks" and "spaces' correspond to different voltage levels between conductors of the network circuit. This is referred to as Non-Return-to-Zero (NRZ) encoding.

Non-Return-to-Zero (NRZ) encoding

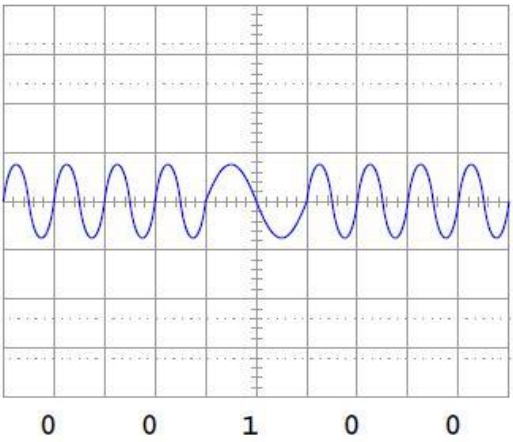


This is not the only way to represent binary bits, though. An alternative method is to use an oscillating (square-wave) signal, counting up and down transitions (pulse edges) at specific times to represent 1 and 0 states. This is called Manchester encoding.



Yet another method for encoding binary 1 and 0 states is to use sine waves of different frequencies ("tone bursts"). This is referred to as Frequency Shift Keying, or FSK, and it is the method of encoding used in the "smart" instrument communications standard.

Frequency Shift Key (FSK) encoding



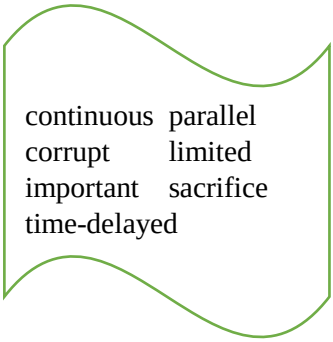
Comprehension

1. Find words in the text that mean the following.

1. The speed and effectiveness of a machine or device
2. A specific problem in part of a process that slows down the whole process
3. The introduction of a new idea, product, technology
4. To succeed in dealing with or controlling a problem
5. To transfer data
6. To physically limit the movement of an object
7. A situation in which something happens later or more slowly than is planned or expected
8. To get something
9. A feature that allows not to be affected by something harmful

10. Very unimportant or small
11. To recognize the difference between things
12. Large in amount or degree

2. Match up the words below into pairs of opposites.



3. Complete the sentences to summarize the text.

1. Digital electronic circuitry has revolutionized the areas of communication and industrial instrumentation because….

2. Most significant benefits derived from digital technology are….

3. Modern electronic technology enables to overcome some limitations that a digital communications system imposes, namely,…

4. Serial data transmission, as opposed to parallel, dominates industrial networks since….

5. Encoding techniques, such as … are required for data transfer along a network.

4. Complete the table below.

System	Channel capacity	Speed	Noise immunity	Resolution
Analog				
Digital				

5. Work in pairs. Compare your ideas with those of your partner and discuss analog and digital system features. Decide on advantages that make digital technology a more perspective choice and think of feasible solutions to overcome digital transmission limitations.

Language Focus

1. You are going to read a text about two types of signals. Before you read, discuss the following questions with your partner.

1. What is a signal?

2. What are the major differences between analog and digital signals?

2. Read the text quickly without paying attention to the gaps to check your ideas. What differences does the writer analyze?

3. Complete the text by filling in an appropriate word in each space. You need to use "grammar" words: articles, conjunctions, prepositions, auxiliary verbs, pronouns. There is an example at the beginning (0).

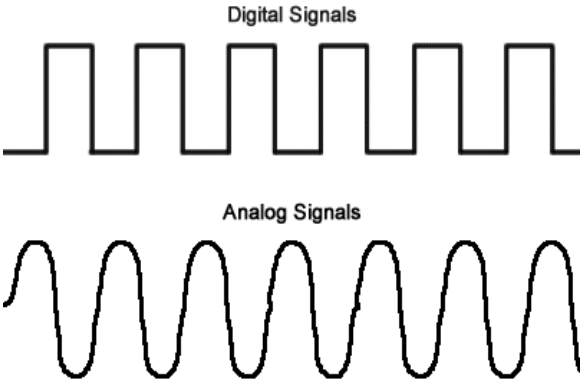
Basics of Analog and Digital Signals

A signal is a visual, audible or any other indication (0) *or* movement used to convey information. Signals are quite crucial to science and technology and divided 1)… two classes: analog and digital. In an analog signal, 2)… signal is varied continuously 3)…respect to the information and can 4)… identified at any instant. On the other hand, the information in a digital signal is encoded 5)… discrete values, i.e. whole numbers. 6)…, consider a sound signal to be measured in a time interval from 0 to 10 seconds. As for an analog signal, it is measured at 0, 0.5, 0.7, 1.5 seconds in values 7)…are known as decimals, whereas a digital signal is only measured at discrete levels 8)… 1, 2, 3, 4 in numbers that are not decimal.

Another characteristic that creates a significant difference 9)…analog and digital signals is the amplitude limitation. Analog signals are independent of the bounds of amplitude. The amplitude depends 10)…intensity of the input

signal. In digital signals, the amplitude has only two states: ON and OFF. At the ON position, the signal has a high amplitude meaning it contains information 11)…at the OFF state, the signal has a low amplitude, which usually means that no significant information 12)…being conveyed through the signal.

In communication, analog signals are used when the data is to be sent over short distance. For analog signal transmission, 13)…the transmitter and the receiver are located in the vicinity of each other so that information can be sent easily or the transmitter should have repeaters that repower data and transmit 14)…to the next destination.



Digital signals are a processed form of analog signals created for communications purposes. To transform an analog signal to a digital one analog to digital converters (ADC) are used. The technical word for creating a digital signal out of an analog signal is called quantization. Analog signals are sampled at short intervals of time in order to be converted into digital. The rate at which they are sampled is called a sampling rate and for a proper conversion, the sampling rate is to be at least twice 15)…fast …the signal frequency. When the sampling rate is higher than the frequency, it is easy to digitize the signal and least amount of information is lost in the process.

4. Read the text about early digital communications systems. The sentences in the extract have been jumbled. Rearrange them in the correct order to make up a meaningful text.

1. A similar code system called the Continental Code was used for early radio communications.
2. In the days when human operators sent and interpreted Morse and Continental code messages, the standard delimiter was an extra time delay (pause) between characters and between words.
3. Morse code used for communicating alphanumerical information over telegraph systems was an early form of digital transmission.
4. The paper strips were then read electrically and converted into a serial stream of on-and-off pulses, which were transmitted along standard telegraph circuit lines.
5. Though being primitive, those codes incorporated basic principles for modern digital serial communications systems.
6. Each letter in the alphabet and each numerical digit (0-9) was represented in Morse code by a specific series of "dot" and "dash" symbols, a "dot" being a short pulse and a "dash" being a longer pulse.
7. Not only could unskilled operators use teletype machines, but also the data rate far exceeded what the best human operators could achieve.
8. The line would be either energized or not corresponding to marks or spaces made on the teletype paper.
9. First, a system of codes is required to represent letters and numbers to spell messages.
10. In later years, when teletype machines were designed to replace skilled operators, the concept of frame delineation became more crucial.
11. Telegraph systems were Boolean in nature representing "dots" and "dashes" by one electrical state of the telegraph line and pauses by another.

12. Next, some means must be employed to distinguish individual groups of bits (generally called frames or packets) from one another not to lose their meaning.
13. When key switches actuated manually were abandoned in favor of teletype machines, and Morse code was replaced by the Baudot (5-bit) code for representing alphanumeric characters, the electrical nature of the telegraph remained the same.
14. However, these machines required special “start” and “stop” signals to synchronize each character transfer, since unlike human operators they could not interpret pauses.
15. Those machines included a typewriter-style keyboard, which marked either paper strips or pages with dots corresponding to the 5-bit Baudot code.
16. A matching teletype machine at the receiving end converted the signal stream into printed characters (a telegram).

5. Evidently, in spite of their drawbacks early communications systems laid the groundwork for modern technologies. **Work with a partner and discuss why those systems are regarded as the precursors of digital transmission.**

6. Establishing methods for multiple devices to share access to a common communications channel is one of the crucial issues to consider before digital apparatus can transmit information to one another.

Read the extract below that addresses this problem. Seven sentences have been removed from the text. Choose from the sentences (A-H) the one, which fits each gap. There is one extra sentence you need not use.

Channel Arbitration

When two or more communication devices exchange data, their communication may be classified into one of two categories: simplex or duplex. A “simplex” network is one-way communication. **1)** _____. A public-address system is another example of a simplex

communication system, since audio information goes only in one direction (from the person with the microphone to the audience).

2) _____. Voice telephony is an analog example of two-way (duplex) communication, where any person at the receiving point can hear the other person talking. **3)** _____. In a full-duplex system, both devices may transmit data to each other simultaneously because they have separate channels (separate wires, or optical fibers, or radio frequencies) for their respective transmissions. **4)** _____. A telephone system is an example of a full-duplex system. A push-to-talk radio system ("walkie-talkie") is an example of a half-duplex system, where each person must take turns to talk.

Most industrial data networks are half-duplex. When more than two devices share a network, there is lack of data channels to allow all of the devices to transmit and listen to each other simultaneously. **5)** _____. In half-duplex systems, there must some way to "inform" devices when they are allowed to transmit. **6)** _____. The problem is analogous to two people pressing the "talk" buttons on their two-way radio units at the same time: neither of them can hear one another, and anyone else on this channel hears the garbled amalgam of those two persons' superimposed transmissions. **7)** _____. The problem of deciding "who" is allowed to "talk" at any given time is generally known as channel arbitration.

A. In a half-duplex system, only one device may transmit at any time because the devices must share a common channel.

B. In order to avoid this scenario in a half-duplex network, there must be some strategy to coordinate transmissions so that only one device may "talk" at a definite moment.

C. A sensor outputting digital data to a remotely located indicator over a digital network is an example of simplex communication, where the flow of information goes from sensor to indicator, and never the other direction.

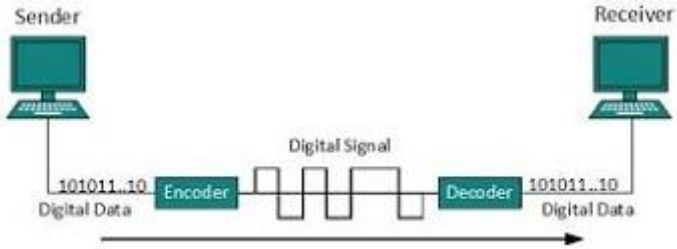
D. Thus, virtually any network supporting more than two devices should be half-duplex and may be limited to simplex operation in some cases.

E. Duplex communication refers to two-way data exchange.

F. Once the data is transmitted, all slave devices may receive that transmission, since they all "listen" to the same communications channel.

G. If multiple devices sharing one communications channel attempt to transmit simultaneously, their messages will "collide" in such a way that no device on the network will be able to interpret either message.

H. Duplex communication is further subdivided into half-duplex and full duplex, referring to whether the two-way communication is simultaneous or not.



Speaking

1. Work in groups of four. You are participants of a TV programme on Discovery Channel. One of you is an interviewer; the others are representatives of a prosperous electronics company, research institute and large industrial enterprise. The debate will be dedicated to achievements in communications systems and perspectives for enhancing data transmission technology.

Brainstorm relevant questions to be discussed, points of view, causes and effects, arguments and counterarguments.

2. Make a presentation of your programme to the group. Decide whose programme is the most interesting and informative.

Writing

1. The popular scientific periodical, whose aim is to get young people interested in science and technology by informing them about breakthroughs in these areas, invites articles on the most promising scientific concepts, remarkable discoveries and significant technological advances.

Write an article about data transmission technologies for this periodical in which outline their features, performance, advantages and drawbacks, perspectives.

Before you start writing, think of

- your target reader
- the style that would be suitable for this article (formal, informal or neutral)
- information it should contain
- features you can use to make the article interesting for your readers (e.g. an attention-grabbing title, an interesting beginning, questions to encourage the readers to think, clear and strong opinions, a thought-provoking ending)

2. Write a plan. Write an article following your plan. Write 180-200 words.

Grammar: The Participle

The participle is a non-finite form that possesses verbal features as well as characteristics of adjective and adverb, which determine its syntactical functions. The participle can be used in sentences to give

extra information or to describe the result, cause or time of the information in the main clause.

There are several participle forms in English.

	Active	Passive
Present (simple)	developing	being developed
Past	--------	developed
Perfect	having developed	having been developed

The Present Participle (I) is formed by adding the suffix **-ing** to the stem of the verb, and the Past Participle (II) – by adding the suffix **-ed** to the stem of the regular verbs, while the irregular verbs have special forms of participle II. Participles have active and passive forms but they do not have a tense. Their time reference is usually clear from the verb in the main clause. The simple forms, both active and passive, are used to describe an action or a state simultaneous with that expressed by the predicate of the sentence (the finite verb).

Making experiments researchers carefully **put down** the results (simultaneous actions).

The perfect forms, both active and passive, express an action or a state, which preceded that expressed by the predicate of the sentence (the finite verb).

Having made a set of tests the engineers **obtained** results of great importance (the perfect participle emphasizes that the first action is completed before the second one starts).

The simple forms may perform two syntactic functions: that of an attribute and that of an adverbial modifier, while the perfect forms may fill only the position of an adverbial modifier, and are never used as attributes.

When participles qualify a noun, they can be used attributively or predicatively.

It is an *exciting* story. The news was *disappointing*.

Like adjectives, single participles in an attributive position usually precede the noun they qualify. When an attributively used participle

forms a phrase, the participle phrase should be put after the noun it modifies.

The *splitting* atoms release much energy. His words had the *desired* effect.

Here is a leaflet *giving* full particulars of the project.

Participle I passive is not often used as an attribute. However, when it is used in this way, it should not be confused with participle II since there is a certain difference in meaning. Participle II expresses merely a state, while participle I passive expresses rather a progressive passive action represented as a state. A participle phrase with participle II is usually rendered in Russian with the help of a participle phrase; while a participle phrase with participle I passive corresponds to a Russian attributive clause with the verb in the form of the imperfect aspect.

I always enjoy reading letters *written* by my sister. – Я всегда получаю удовольствие, читая письма, *написанные* моей сестрой.

The director will sign the letters *being written* by the engineer. - Директор подпишет письма, *которые сейчас пишет* инженер.

Participles can often function like clauses of reason, condition, result and time.

	Full clause	Participle phrase
reason (cause)	She will be unable to answer your queries **because she is not qualified**.	**Not being qualified**, she will be unable to answer your queries.
condition	**If you treat it carefully**, the device should last for years.	**Treated carefully**, the device should last for years.
result	The corporation shut down the plant, **with the result that many workers were left unemployed**.	The corporation shut down the plant, **leaving many workers unemployed**.
time	**When they were questioned**, they gave very careful answers not to make a mistake.	**Being questioned** they gave very careful answers not to make a mistake.

Participles can also function as adverbial modifiers:

– of attendant circumstances:

I wrote him a friendly letter, *thanking* him for his help.

– of comparison:

She paced up and down the room restlessly as if *trying* to make some decision.

– of concession:

Though *astonished* by her interest in the details of the accident, I went on with my story.

Participles in the adverbial function may be preceded by conjunctions: *when, while, if, as if, as though, though, unless*.

Participle I may also be used as a parenthesis, i.e. it is not logically related to the subject of the verb but serves to introduce a new idea, to connect two ideas or to add a comment. In this case, a number of set expressions are mostly used: *generally speaking, strictly speaking, roughly speaking, granting it to be true, judging by, judging from* etc.

Generally speaking, they are pretty friendly people.

We can use an adverb to modify a participle. This describes the particular aspect of something that we are commenting on. The adverb can come before or after the participle.

Speaking quickly at the exam, he made several mistakes.

1. Complete the sentences with the correct participle form of the verbs in brackets. There is an example at the beginning (0).

0. While (design) a new device, the inventor made many tests.
While *designing* a new device, the inventor made many tests.
The problem (discuss) now is of great importance.
The problem *being discussed* now is of great importance.

1. When (compare) elements one notices the outstanding stability of some electronic structures.

2. In physics and chemistry as well as in other exact sciences the quality of the instruments (use) can be safely (rely upon).
3. You should not waste time (dwell) on that old situation.
4. (Consider) the problem for an hour already, they could not achieve the conclusion yet.
5. The article (type) will (publish) in the next issue of the journal.
6. The transformer operates (use) two coils of wire or inductors (call) the primary and the secondary.
7. (Heat) for several hours, the substance began to melt.
8. For astronauts on months' or even years' long journeys to distant planets, biological batteries might solve a dual problem. They could serve as a waste disposal system while (provide) power for equipment and instruments.
9. Unless (speak), he never says a word himself.
10. (Not to know) the instructions we could not use the equipment.
11. The speaker kept silent as if (wait) for the statement to be interpreted.
12. The questions (discuss) were (include) into the agenda of the meeting.
13. (Do) all that was required, he left the office.
14. Before the discovery of the structure of atomic, it was thought that there existed two types of forces (explain) all natural phenomena: electrical and gravitational forces.
15. The photograph shows the light (produce) by a helium-selenium laser, one of a class of lasers that operate with a vaporized metal (mix) with another gas.
16. (Subject) to all the tests, the machine was (introduce) to the plant.

2. The sentences below contain mistakes in the use of participles. Find and correct mistakes.

1. While having looked through the documents he found several errors in them.
2. Been a good mixer she easily makes friends.
3. Solving the main problem the scientist made a report on his discovery.
4. He will certainly help you with your project if asking.
5. The colour of the light been seeing is determining by the frequency of the light waves affected the human eye.
6. The forces held the individual atoms together as a unit are much greater than those, which are acted when being combined with other atoms.
7. A capacitor is a device consisted of conductors having separated by a dielectric, which may be air or vacuum, intending for introducing capacitance into an electric circuit or system or providing the storage of electricity.
8. When made observations from above the ionosphere radio telescopes can be using at much lower frequencies.
9. The properties being discovered required further investigation.
10. The scientist theoretically predicted complicating interactions between the components involving in the process.
11. The world's first nuclear-powered lighthouse having been operated by a radiation-powered isotopic generator that keeps recharging an energy storage system has recently being put into operation.
12. If the type of particle been detected can be identifying, then its energy can been calculated.
13. Charging particles having passed through matter experience collisions because of which they are scattering and lose kinetic energy.

14. Superconductivity is the name giving to a phenomenon showing by some conductors of electricity, which lose electrical resistance when having cooled below a certain temperature.
15. The letter begun with “Dear sir” was not signing.
16. Generally, the parameters being listed are those considering most relevant to the class of application the transistor was being designed for.
17. The chairperson having been opening the conference said a few words of greeting.
18. The information having received is been carefully studied by the experts.
19. Owning a watch, Peter was often late.
20. Read the article he knew what I meant.
21. The method using depended on the material being selected.
22. Some of the video waveforms in radar are very different from sine waves but it is still possible to deal with these waves in certain cases on the sine wave basis used Fourier theory.

3. Replace the subordinate clause with a suitable participle phrase. Define the function of participles. There is an example at the beginning (0).

0. Since I saw that she did not understand me, I said it again.
Seeing that she did not understand me, I said it again (an adverbial modifier of cause).
The article that was written ten years ago has not lost its significance.
The article written ten years ago has not lost its significance (an attribute).

1. As I am not very good with figures, I will let you do the accounts.
2. If you give them enough time, the engineers will be able to find the fault.

3. When we arrived at the airport, we learned that our flight was delayed because of weather conditions.
4. Because all bodies have a constant downward acceleration, which is produced by the pull of gravity, the equations of uniformly accelerated motion can be applied to any bodies, which are falling.
5. An Earth satellite if it is launched into an orbit sufficiently distant from the Earth's surface can circulate for months or even years.
6. One short pulse of light that is emitted as a parallel beam, when it is focused by a lens carries sufficiently concentrated energy.
7. The motor is overheated unless it is cooled.
8. Though the test was conducted with great care, it did not give the results that were expected.
9. When the chemical energy is transformed into electric energy, it is partially changed into heat.
10. She looked as if she was frightened by something.
11. Because he had been unemployed for so long, Jack despaired of ever finding a job.
12. While one is solving a problem, he should take into consideration all the existing methods that are related to the problem in question.
13. Although the substance was discovered long ago, only now it is widely used in industry.
14. According to Newton's first law of motion an object remains at rest or in a straight-line motion unless it is acted upon by some external force.
15. The instruments were broken while they were being transported.
16. As the driver was caught exceeding the speed limit, he had to pay a fine.

4. Use Present or Past Participle of the given verbs to complete the sentences.

1. It was ___ work. He was ___ (exhaust).
2. The film was so ___. Everybody was ___ by it (excite).
3. It was such a ___ problem. We were all ___ by it (confuse).

4. The results are ___. Everyone is ___ (disappoint).
5. It is ___ news. They are ___ (shock).
6. The view is ___. Tourists are usually ___ (fascinate).
7. The atmosphere was ___. We felt ___ (depress).
8. Her chatter is ___. We are ___ (annoy).
9. Their argument was ___. He was ___ by it (convince).
10. The book is awfully ___. I am so ___ reading it (bore).

Predicative Constructions with Participles

If a participle has a subject of its own, it forms together with its subject a predicative construction. There are four predicative constructions with participles.

1. The Objective Participial Construction

The verbs of sense perception (*feel, hear, notice, observe, perceive, see, watch, listen*) and the verbs *to have, to get* are often followed by *the objective participial construction (the complex object),* i.e. by a noun (in the common case) or a pronoun (in the objective case) and a participle, standing in predicate relation to each other. When translated into Russian, both parts of the construction correspond to the subject and predicate of a subordinate object clause.

I left *her reading* in the room. She left *the letter unfinished*.

The objective-with-the-infinitive construction is also used after these verbs, the only difference being that the construction with participles describes the action as being in progress, while the infinitive is used to denote a complete action.

After the verbs *to imagine, to smell, to look (at), to keep, to catch, to set, to start, to leave, to send* the objective-with-the-infinitive construction is never used. The only possible construction after these verbs is the objective participial construction.

Please, help me to start these *mechanisms working*.

After the verbs *to make, to get, to like, to want* the construction is used only with participle II.

I want *everything done* today.

The objective participial construction with participle II, when used after the verb *to have*, has a special meaning, i.e. it expresses the idea of something done for the person, expressed by the subject of the sentence.

I had *my laptop repaired*.

2. The Subjective Participial Construction

When the subject of the sentence and the participle stand in predicate relation to each other, they form *the subjective participial construction (the complex subject)*. This construction is used when the predicate of the sentence is expressed by one of the verbs of sense perception in the passive voice.

They **were seen** *speaking* to the dean.

This complex is formed only with participle I in the active voice.

It should be mentioned that a sentence containing an objective participial construction might be transformed into a sentence with a subjective participial construction.

I **saw** *him driving* a car. *He* **was seen** *driving* a car.

3. The Nominative Absolute Participial Construction

The participle used as an adverbial may be preceded by a noun (in the common case) or a pronoun (in the nominative case) functioning as its subject. The whole complex called *the nominative absolute participial construction* makes a clause functioning as an adverbial modifier of time, reason, condition, manner or attendant circumstances. We separate it by a comma from the main clause. In Russian, the complex matches a corresponding adverbial clause. However, the absolute participial construction is literary rather than colloquial.

The necessary data having been obtained, we could complete our research. – Когда были получены необходимые данные, мы смогли завершить исследование.

When functioning as an adverbial modifier of manner or attendant circumstances, this construction occupies the end position in the sentence. In these cases it corresponds in Russian to the second part of

a compound sentence (often introduced by the Russian conjunctions причем, тогда как, а).

Hydrogen is the simplest substance, *atoms of other elements having a more complex structure*. – Водород – простейшее вещество, тогда как атомы других элементов имеют более сложную структуру.

4. The Prepositional Absolute Participial Construction

The subject of the participle used as an adverbial to the predicate in the main clause may be introduced by the preposition *with*. In this case, the subject is expressed by a noun in the common case or a pronoun in the objective case. The noun (or pronoun) together with the preposition *with* and the participle form the so-called *prepositional absolute participial construction*. It is always separated from the main clause by a comma. The complex mostly functions as an adverbial modifier of manner or attendant circumstances, occasionally as an adverbial modifier of time or an attribute.

With the equipment having been delivered, the scientists started their investigation. – После того как оборудование было доставлено, ученые приступили к исследованию.

1. Change the sentences using a suitable predicative participial construction. Define the type of a construction.

1. I saw how he was leaving the house.
I saw *him leaving* the house (the complex object).
2. It was seen that she was crossing the street.
She was seen *crossing* the street (the complex subject).
3. When the decision had been taken, nothing could make her give it up.
The decision having been taken, nothing could make her give it up (the nominative absolute participial construction).

1. She heard that his name was mentioned several times.
2. Since the visit was a success, the plans for the forthcoming meeting were worked out.
3. They considered that the problem had been discussed.
4. When our previous errors had been corrected, we could proceed with the evaluation of the results obtained.

5. We watched how the cars were being loaded.
6. The editor wants that the report will be published in the today's issue.
7. When the greetings were over, the speaker began his speech.
8. They kept him waiting for a long time.
9. When Newton's work was published, scientists realized it could serve many purposes.
10. It was heard that they were arguing loudly.
11. There were no arguments, and the plan was approved.
12. He heard that the question was repeated.
13. The new equipment has just been received, and tests conducted under operating conditions have shown its high quality.
14. We saw how her plane was coming in to land.
15. Microelectronics surrounds the entire body of electronics the term itself appears in many forms such as microminiaturization, microsystem, etc.
16. They had to fix the installation since it did not work properly.

2. In the sentences below, define the function of the nominative absolute participial construction.

0. His project completed, David left the team (an adverbial modifier of time).

1. The device being repaired, we will be able to use it in our research.
2. The terms of agreement changed, we are ready to sign it.
3. Reduced weight and size are particularly important, miniaturization becoming the necessity in order to reach the high speed.
4. The new rules having been adopted, they had to follow them.

5. With the computer having become a common business tool, the information can be stored in electronic memories and got out by pressing a button.
6. The digital technology invented, the problem of noise in signal transmission was solved.
7. The effect is highly dependent upon frequency, the lower frequencies showing less noise.
8. The voltage being very low, the machine tool would not operate properly.
9. The X-ray method of examining inner organs being to a certain extent harmful, scientists have developed a new technique of ultrasonic examination.
10. The telescope system being in orbit, reliable remote control from the ground must be provided.
11. With the current being switched on, the machine automatically starts operating.
12. The distance having been measured, the computer adjusts the car's speed.
13. A diode is any electronic device consisting of two elements, one being an electron emitter or cathode, the other an electron collector or anode.
14. With the experiments having been carried out successfully, they started mass production of the device.
15. A single component having failed, the whole cable system was repaired.
16. They tested various methods, with no results meeting the requirements.
17. The insulation being poor, the short circuit was practically inevitable.
18. Improved means for modulating electrical signals having been provided, the device performance became very effective.

UNIT 2 Digital Carrier Systems

Lead-in

1. Data transfer can be implemented by carrier techniques or voice-frequency transmission.

Work with your partner and discuss advantages of carrier technology over voice-frequency transmission (consider the factor of economy – the number of channels needed to transmit data, cost of transmission, accuracy, reliability).

Work with another pair. Compare your ideas and decide which technique is more efficient.

2. Select some words that you would expect to find in an introductory text about transmission systems.

carrier level wire power supply channel interference error bandwidth capacity loop modulation spectrum frequency range wave conversion speed trunk format code

Add some more words related to data transmission systems. Make up sentences on the subject using the words from your lists.

Reading

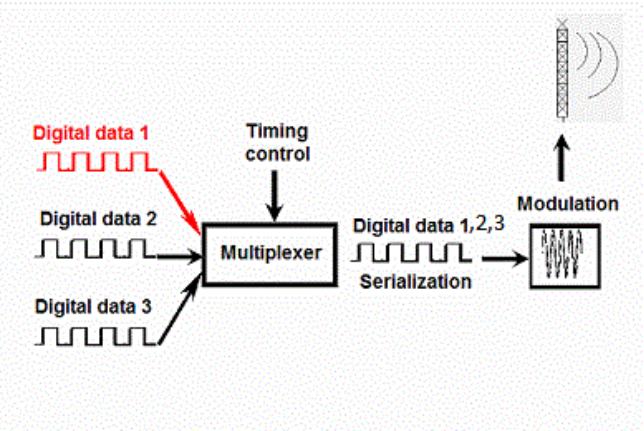
1. You are going to read a text about transmission systems. First, look through the text and decide which paragraphs are about these subjects.

- …..- Digital carrier system application
- …..- Telecommunication transmission procedure
- …..- Digital transmission system operation
- …..- Carrier technique advantages

2. Read the text more carefully and see if you find the words you selected.

A. A telecommunication transmission link can be either a loop, which connects a user with a serving office, or a trunk, which connects two offices. Telephone transmission is implemented at voice frequency, or a number of voice-frequency channels can be multiplexed together using frequency-division techniques (analog carrier) or time-division techniques (digital carrier). The multiplexed signal can then be transmitted over guided wave media, such as wire and optical fibers, or through free space as in radio systems.

B. The advantage of carrier techniques over voice-frequency transmission consists in the greater economy due to carrying many channels on a single medium element. Though *this* reduces the cost per channel mile, the cost is incurred in multiplexing the channels for transmission. Therefore, at first carrier systems were applied on long routes with many channels. Lower-cost digital multiplexers introduced in the early 1960s made it possible to use digital carrier in the exchange area under 50 miles. Digital carrier with digital switches eliminates the cost of digital-to-analog conversion *that* is required for a voice frequency or analog trunk and can be more economical than voice-frequency transmission.



C. The first digital carrier was the 24-voice channel 1.544 Mb/s T1 system introduced in the USA in 1962 for short-haul (up to 50 mi) application. The major advantages of T1 over short-haul analog systems were the lower-cost terminals due to the ease of handling signal information on a digital system, a single codec (coder-decoder) sharing along 24 channels, and the economy of time-division multiplexing. T1 and subsequent higher-speed digital systems on a pair of coaxial cable and optical fiber dominated short- and medium-haul trunk applications for some years, and loop carrier was successfully introduced to loop applications. Digital fiber-optic systems have higher capacity and are much cheaper than analog coaxial systems. Fast development of digital systems – particularly in short- and medium-haul applications - have been urged by the need for digital connectivity *arising* from consumer requirements and the widespread use of digital switches.

D. Voice channels are converted to digital form and multiplexed into 24- or 30-channel digital groups in a primary pulse code modulation (PCM) multiplex. PCM is also *called* a digital channel bank. If the channels are in digital form in a digital switch, the format for transmission is performed in an exchange terminal. The resulting primary-rate signal might then be transmitted *directly* to another switch or multiplexed with other signals to a higher rate before transmission. This multiplexing may be performed in separate multiplex or by the transmission system proper. The functions available in the terminal equipment of various transmission systems include monitoring of digital errors in transmission, power feeding for line repeaters, techniques for locating a defective line repeater, automatic switching to spare equipment (line or terminal) in case of failure. Other functions are automatic insertion of special signals (called AIS for alarm indication signal or "blue" signals) in case of loss of normal signal, generation of office alarms, and system-status reporting to central maintenance locations.

Comprehension

1. Which of these makes the best title for the whole text?

1. Transmission Systems for Telecommunication.
2. Transmission System Principles.

3. Transmission Systems – Overview.
4. Digital System Design and Operation.

Think of your own title for the text.

2. What do these words refer to?

1 *this* (paragraph B)
a) voice-frequency transmission b) carrier techniques c) economy
2 *that* (paragraph B)
a) an analog trunk b) digital-to-analog conversion c) digital carrier
3*arising* (paragraph C)
a) digital connectivity b) short-haul applications c) need
4*called* (paragraph D)
a) a primary PCM multiplex b) digital form c) digital groups
5 *directly* (paragraph D)
a) transmission b) transmitted c) multiplexed

2. According to the text, are the following statements true or false? If they are false, explain why.

1. Similar multiplexing techniques are used for both analog and digital carrier.
2. Carrier techniques allow carrying many channels on a single medium, and consequently, provide greater economy than voice-frequency transmission.
3. Carrier technology is suitable only for long-haul applications.
4. High-speed digital systems dominated short- and medium-haul trunk applications for some years because of significant advantages over analog systems.
5. Consumers prefer analog systems rather than digital ones.
6. A primary pulse code modulation multiplex or a digital channel bank is one of the essential components for the process of converting voice channels to digital form.
7. The terminal equipment of a transmission system performs a very limited number of functions.

Language Focus

1. Fill in the gaps in the sentences below with the appropriate form of the words given.

1) *transmitted, transmitting*

Once data are *a)*… in pulsed form at an appropriate repetition rate, the advantage is that the same channel may be used for *b)*… of several sets of information by time-multiplexing technique.

2) *obtained, obtaining*

The designer must evaluate all means of … the desired system performance.

3) *made, making*

Better characteristics can be achieved by … the equipment more durable, mechanically and electrically.

4) *transmitted/transmitting, received/receiving*

In most systems, a single antenna is used for both *a)*… and *b)*….

5) *been, being*

The instrument has the additional advantage of …very simple and inexpensive in construction.

6) *developed/developing, applied/applying*

Nowadays innumerable components and systems are *a)*…for *b)*…in telecommunication and data- processing as well as in radio and TV.

7) *proposed/proposing, based/basing*

A new *a)*…worldwide telecommunications system *b)*…on transmitters in space has the ability to connect two people anywhere on the globe.

8) *spaced/spacing, linked/linking*

The system includes 77 satellites uniformly *a)*…475 miles above the earth and *b)*…by digital signals to form a cellular network.

2. Telecommunication has merged with computer technologies to make the entire spectrum of voice, data, and graphics available. **Read the text about Teletext and Videotex systems and decide which answer A, B, C, or D best fits each space. There is an example at the beginning (0).**

Teletext and Videotex are information communications systems, which provide *(0) B* to visual (text or graphics) information.

Teletext is based on a broadcast capability (airwave or cable). Frames are transmitted as coded data rather than in video form to 1)…equipped television receivers. A large number of these frames are continuously transmitted from an information-storage 2)…in cyclic order during the vertical blanking interval of an in-use television channel or in an 3)… unused video channel. A user typically selects the frame or frames desired for viewing by 4)…frame-identification numbers on a key pad. The receiver 5)…the data signal associated with the desired frame from the overall bit stream. The data signals are then decoded, and information is stored in the Teletext receiver 6)…display on a television set.

Videotexis based on a two-way 7)…telecommunications system network (telephone or data). Information can be displayed on 8)…television sets or on special-purpose data-display terminals. Information is transmitted as modulated data bi-directionally between the 9)… and the information source, which consists of a computer system and associated databases. A user selects the desired information 10)…the terminal input device, typically a key pad or a keyboard. User-to-user communications are possible with Videotex 11)…the use of telecommunications networks for transmission.

Although Teletext service has a greater transmission bandwidth and hence higher data-transmission speed than Videotex service, the total number of frames 12)… from the information source is much smaller due to the limited time a user is willing to wait for the desired frame to be "captured" from the continuously transmitted 13)… of frames. On the other hand, Teletext allows 14)… information access by a virtually unlimited number of users, while Videotex service has a limited

simultaneous user capability due to 15)… on the information source unless additional computers are provided.

0. **A** input **B** access **C** source **D** feedback

1. **A** suitably **B** properly **C** substantially **D** efficiently

2. **A** device **B** equipment **C** utility **D** facility

3. **A** entire **B** whole **C** complete **D** overall

4. **A** pushing **B** typing **C** entering **D** arranging

5. **A** eliminates **B** extracts **C** selects **D** sorts out

6. **A** to provide **B** to generate **C** to permit **D** to hold

7. **A** connected **B** transmitted **C** fed **D** switched

8. **A** modified **B** varied **C** updated **D** transformed

9. **A** display **B** terminal **C** storage **D** processor

10. **A** through **B** by means of **C** across **D** via

11. **A** because of **B** owing to **C** thanks to **D** according to

12. **A** suitable **B** available **C** appropriate **D** sufficient

13. **A** stream **B** flow **C** array **D** chain

14. **A** the same **B** continuous **C** simultaneous **D** permanent

15. **A** supplying **B** loading **C** communicating **D** transferring

3. The article below is about the digital flight data recorder, the system that is vitally important for preventing aircraft accidents. **While reading the article, complete it using the words and phrases in the box.**

an applied load force crash-proof container sensors
recording media similar circumstances filtration
an analog format a binary signal to determine
a sonar transmitter a crucial component moving parts

Digital Flight Data Recorders

A flight data recorder is a system designed to collect and record data from a variety of 1)…. These sensors are mounted throughout the aircraft to pick up data from appliances, components and co-dependent systems. All of this data is collected and stored digitally within a reflective, fluorescent yellow or orange 2)….

The collected data is critical in assisting accident investigators to understand what went wrong and caused an aircraft accident, especially if there are no survivors. Obviously, without this information there is a high probability that a similar accident might occur on another aircraft under 3)….

The Digital Flight Data Recorder (DFDR) provides data for designing the faults that are most likely to cause a catastrophe. Thus, it allows eliminating a disastrous repeat of accidents. Another benefit of the DFDR system is that it can become 4)…in a condition monitoring and reliability program.

The DFDR must meet a set of requirements, a high degree of "crashworthiness" being of vital importance. The unit must withstand a momentary shock force and a static crushing force at all of its six axis points of 5)…of 5,000 lbs for 5 minutes on each axis. It is also required that these units are mounted within the tail area of an aircraft, away from the potential crushing force of engines mounted nearby. The DFDR must be watertight to a depth of 20,000 feet in seawater, and survive at this depth for 30 days. It must be fitted with an underwater locator beacon which will act like 6)…sending a signal through the water that it might be laying in.

The first FDR was invented in 1939 and developed into a useable flight unit in the late 1940s. The first systems were quite simple because they were entirely electro-mechanical units with a foil as the 7)…and five styluses that scratched readings for Heading, Altitude, Airspeed, Vertical Acceleration and Time on one side of the foil. Soon this system was enhanced by adding three more styluses on the opposite side of the foil for Pitch, Roll and Flap information (total eight parameters).

With the arrival of the digital unit both the survivability and reliability of this valuable monitoring system radically improved thanks to the elimination of tapes, drive motors, belts, and all other 8)…that were necessary with all previous versions.

Prior to the introduction of the DFDR, all data was recorded and stored in 9)…. Analog data transmission systems easily pick up any noise along its transmission wiring caused by poor insulation, local interference and random thermal vibrations of the atomic particles in the wire conductors as well. All variations to the original analog signal appear as noise. As the signal is transmitted over long distances, this noise if not filtered ultimately degrades the signal sent from the parameter sensor. Digital data transmission systems convert the input data into 10)…, i.e. a square-wave signal that is a pulse representing either an "on" or "off", or a "1" or "0". This digital signal is not affected by noise, and therefore delivers pure, unaltered data to the receiving DFDR without the need for 11)…, and the fear of losing signal data.

Every data input signal sent through a wire channel for a specific monitored system component or condition is called a parameter. The Type 1 DFDR records all of the parameters required 12)…accurately the aircraft's flight path, speed, attitude, engine power, configuration and operation. The Type 2 and 2A in addition record configuration of lift and drag devices.

Today, the internationally recognized standard for digital data transmission on-board aircraft through an open digital-data-bus is ARINC standard 429, which employs unidirectional transmission of 32- bit words over two-wire twisted pairs.

ARINC is also the inventor and developer of the Aircraft Communications Addressing and Reporting System (ACARS), along with the concept of reliability analysis as it relates to Mean Time between Failure (MTBF) for avionics systems.

(The extract from the article by Jeremy Cox, a former pilot and aircraft engineer, currently Vice President at Jet Brokers, Inc., a professional aircraft sales company).

Speaking

Imagine that you work for a company manufacturing digital systems for industrial applications. Your team of three or four people is responsible for developing a strategy for your latest product promotion to the market. Your team's tasks are:

- ✧ Decide on your target customers
- ✧ Prepare a presentation for a focus group to inform potential customers about benefits of a product (its technical characteristics, performance, price, etc.)
- ✧ Make a plan for your company's advertising campaign specifying which advertising media (newspapers, specialized magazines, Internet, television, radio, posters and mail) to use to communicate your message.

Writing

1. Working in groups, write a script for a commercial to be broadcast on TV, radio or the Internet to advertise your product.

Think of a slogan for a product and possible effects (music, sounds) in addition to a voice to make your commercial more attractive and persuasive.

2. Role-play your commercial to the group.

Grammar: The Gerund

The gerund is a non-finite form of the verb with some noun features. It is formed by adding the suffix ***-ing*** to the stem of the verb.

As a noun, it can function as the subject of a sentence, a direct object, as a predicate nominative, etc. As a verb, it can be followed by a predicate nominative or a predicate adjective; it can, if it is transitive, take a direct object; and it can, if it is a verb of saying, giving, or showing, take an indirect object. As a noun, it can be modified by adjectives and by words functioning as adjectives (nouns, prepositional

phrases, etc.). When functioning as an attribute or an adverbial modifier, the gerund, like a noun is preceded by a preposition.

There is a chance *of catching* the train (the gerund as an attribute).

The gerund has grammatical categories of tense, and (in the case of transitive gerunds) voice, but not person and number. As a verb, it can be modified by adverbs and by words functioning as adverbs (adverbial objectives, prepositional phrases, etc.).

Reading (the gerund) *quickly* (an adverb) tires me.

A gerund with its complements, objects, and modifiers constitutes *a gerund phrase*. Gerund phrases can, like simple gerunds, function as subjects, predicate nominatives, direct objects, objects of prepositions and adverbial objectives.

- The subject of the sentence.
  Finding a needle in a haystack would be easier than what we are trying to do.
- The **direct object of a verb**.
  I hope that you appreciate **my offering** you this opportunity.
- The **object of a preposition**.
  You might get in trouble for **faking an illness** to avoid work.

Forms of Gerund

	Active	Passive
Simple	writing	being written
Perfect	having written	having been written

The simple gerund expresses an action simultaneous with that expressed by the finite verb in the main clause.

*I hate **arguing** with you* (*arguing* refers to the same time as *hate*: I hate when we argue.).

The **simple gerund** can also refer to a time before that of the verb in the main clause.

*I do not remember **saying** anything like that* (*saying* refers to a time before *do not remember*: I do not remember that I said anything like that.).
*She regretted **not studying** harder when she was at school* (*not studying* refers to a time before *regretted*: She regretted that she had not studied harder when he was at school.).

The **perfect gerund** expresses an action prior to that expressed by the finite verb in the main clause. However, it is only used if the time of the action expressed by the gerund is not obvious from the context:

*He denied **telling a lie*** (the simple gerund *telling* refers to the same time as *denied*- He denied that he told a lie.).

*He denied **having told a lie*** (the perfect gerund *having told* refers to a time before *denied* - He denied that he had told a lie.).

The gerund of transitive verbs possesses voice distinctions. Like other verb forms, **the active gerund** points out that the action is directed from the subject (whether expressed or implied), whereas **the passive gerund** highlights that the subject is somehow affected and the action is directed towards the subject.

*I hate **being lied to*** (the passive simple gerund - I hate it when people lie to me.).
*He complained of **having been** unjustly **accused*** (the passive perfect gerund - He complained that they had unjustly accused him.)

Functions of Gerund.

In sentences the gerund functions as the subject, predicate, part of a compound verbal predicate, attribute, adverbial modifier (of time, manner, attendant circumstances, condition, cause).

1. *Analyzing* the facts is the first stage in the work of a scientist (the subject).

2. The purpose of solar batteries is *converting* the energy of the sunrays directly into electric energy (the predicative, part of the compound predicate).
3. The scientists began *utilizing* this practically unlimited source of energy (part of the compound verbal predicate).
4. He remembered *inspecting* the system for leaks (a direct object with the verbs *to remember, to avoid, to doubt, to mention, to respect, to suggest, to mind, to excuse, to forgive, to enjoy, to require*).
5. He succeeded *in performing* the experiment (a prepositional object).
6. The thermometer is an instrument for *measuring* temperature (an attribute).
7. After *finishing* the experiment, they discussed the results (an adverbial modifier of time). We can improve the device by *making* it lighter (an adverbial modifier of manner). Compressors are used for *obtaining* strongly compressed gas (an adverbial modifier of purpose). Solids expand in case of *heating* (an adverbial modifier of condition).

Note.

- As an adverbial modifier of time, the gerund is preceded by the prepositions *after, before, on (upon), in, at* and *through.*
- The prepositions *for, for (with) the purpose of, for the sake of, with a (the) view of* precede the gerund functioning as an adverbial modifier of purpose.
- The prepositions *by, by means of, without, in, like* precede the gerund functioning as an adverbial modifier of manner.
- As an adverbial modifier of attendant circumstances, the gerund is preceded by the prepositions *without, instead of, besides, apart (aside) from, in addition to, together with, beyond.*

- The prepositions *without, in case of, in the event of, subject to* precede the gerund in the function of an adverbial modifier of condition.
- The prepositions *for, for fear of, owing to, on account of, because of* precede the gerund in the function of an adverbial modifier of cause.

The gerund and the infinitive are very common forms in English having similar features and functions. Therefore, we should be aware in which cases either verbal is possible and in which ones only the gerund or only the infinitive occurs.

Certain verbs can be followed by a gerund, but not by an infinitive.

admit, appreciate, avoid, can't help, consider, delay, deny, dislike, endure, enjoy, escape, excuse, face, fancy, feel like, finish, give up, imagine, involve, justify, keep, mention, mind, miss, postpone, practice, prevent, put off, recall, recommend, resist, risk, save, suggest, tolerate, understand

I **avoid travelling** in the rush hour whenever possible.

Certain verbs can be followed by an infinitive, but not by a gerund.

afford, agree, aim, appear, arrange, ask, attempt, care, choose, decide, demand, deserve, expect, fail, fight, forget, guarantee, happen, help, hesitate, hope, intend, manage, need, neglect, offer, pause, plan, prepare, pretend, promise, propose, prove, refuse, seem, tend, threaten, trouble, try, undertake, wait, want, wish

She has **decided to apply** for the job.

Some verbs can be followed by a gerund or an infinitive, with no difference in meaning: *attempt, begin, bother, can't bear, can't stand, cease, continue, deserve, fear, hate, intend, like(= enjoy), love, prefer, start.*

We **began translating** this article an hour ago. / We **began to translate** this article an hour ago.

Some verbs can be followed by either a gerund or an infinitive, but there is a difference in meaning.

verb	**+ gerund**	**+ to + infinitive**
forget/remember	=forget/remember an earlier action: Do you **remember going** to school for the first time? I will never **forget meeting** him.	=forget/remember to do a future action: I must **remember to set** my alarm clock tonight. Don't **forget to lock** the door.
go on	= continue: They **went on planning** their project.	= change to another action: After opening the hospital the chief **went on to meet** the staff.
mean	= involves or will result in: This new job **means living** abroad.	= intend to do something: The designers **mean to finish** by Friday.
regret	= feel sorrow about the past: I really **regret getting** that tattoo when I was eighteen.	= announce bad news: We **regret to inform** you of delays in today's service.
stop	= finish an action: They **stopped making** fax machines about ten years ago.	= finish one action in order to do another one: We **stopped to get** petrol.
try	= do something to see what will happen:	= make an effort to do something difficult:

	Try using another reading strategy.	We **tried to get** tickets but the show was sold out.

The Gerundial Complex

The doer of the action denoted by a gerund may be expressed by
a) a noun in the possessive case or a possessive pronoun;

b) a noun in the common case;

c) a pronoun in the objective case.

These combinations are called **the gerundial complex** whose functions are similar to those of a simple gerund.

I insist on doing it. I insist on **your doing** it.

There is another form in English ending in *-ing* known as a verbal noun. It should be differentiated from a gerund since it is an ordinary noun and possesses all noun features. For instance, in the sentence – *We were caught in traffic and missed the beginning of the game – beginning* is a verbal noun; however, *beginning* is a gerund in the sentence – *You cannot read most novels successfully by beginning in the middle*.

1. Complete the sentences with the appropriate gerund form of the verbs in brackets. There is an example at the beginning (0).

0. There is no chance of (convince) him.

There is no chance of *convincing* him.

1. (Put) things tomorrow can no longer be tolerated.
2. In spite of (be busy), he did not refuse to help us.
3. The thing I most enjoy about my job is (help) people with their problems.
4. You will not find any spare parts; they stopped (make) them ages ago.
5. I hate (interrupt) people as well as I hate (interrupt).

6. We know of his (complete) the research.
7. The engineers were busy (test) a new engine.
8. We insisted on the meeting (put off).
9. After (record) the results, they started (analyze) them.
10. I hate (bother) when I work.
11. The rules of (operate) this machinery are very simple.
12. Specialists were not sure, if it was possible to continue (modernize) the electronic equipment of this kind since the costs were too high.
13. I remember (read) this article.
14. On (complete) the course, he got a special certificate.
15. I am so grateful to you for (explain) me everything.
16. He avoids (ask) any personal questions or (ask) any even by his closest friends.
17. Gamma rays differ from visible light only in (have) a much higher frequency and shorter range.

2. In the sentences below, define the function of a gerund. Insert prepositions where necessary.

1. The act… transmitting a signal from one frequency band to another is called modulation.
2. We can increase the current… reducing the resistance of the circuit.
3. Committee objected…taking any decision without a thorough discussion.
4. …Being informed of the conference, he immediately decided…participating in it.
5. Research is carried out…modifying known polymers with the purpose…developing desired properties in them.

6. …Repeating experiments one gets more data that help…arriving at right conclusions.
7. It is no use…discussing the question.
8. He was accused…selling the information to firms-competitors.
9. It is possible to facilitate the escape of an electron from a conductor…increasing its speed.
10. ..Leaving the earth means…moving upwards against gravity and this requires work.
11. ..Converting electrical energy into mechanical energy, we use a special machine called a motor.
12. One of the most effective aids…planning is…simulating.
13. ..Translating from one language into another has been accomplished by a computer.
14. A wide variety of instruments capable…detecting and measuring different types of radiation are applied nowadays.
15. The classical laws of both mechanics and electricity fail…predicting the behavior of atoms.
16. Researchers have obtained data about the distribution of nuclear charge…carefully studying the optical spectra.
17. Microelectronics also includes the technique…putting large numbers of electronic elements on silicon chips when making electronic devices.
18. Scientists succeeded… developing means…creating synthetic rubber with properties similar to those of natural rubber.
19. One of the aims…studying foreign languages is…receiving more information on one's specialty.
20. ..Formulating the problem, the scientist should choose, modify or design the procedures for an experiment.
21. The driver could not check all connections for leakage…the engine being hot.

22. ..Being small in size equipment made of transistors is lightweight.
23. ..Connecting two conductors of the same material and of the same length and size in parallel provides the same effect as a single conductor twice as large as either of the two.
24. The engineers were busy…testing a new engine.
25. An X-ray spectrometer makes it possible to determine the chemical composition of the substance… injuring its structure.
26. ..Our applying the devices for rather a short period, they play a vital part in person's life all over the world.
27. Persuasion is the art… getting other people to do or believe something… being compelled to do so.
28. He went on… talking… having been interrupted.

3. Replace the subordinate clause with a suitable gerundial construction. Use prepositions where necessary. There is an example at the beginning (0).

0. I hope you will forgive me that I have disturbed you.
I hope you will forgive *my disturbing* you.
I insist that you show me your work today.
I insist *on you showing* me your work today.

1. Once he decides something, it is impossible to talk him out of it.
2. Do you think there is any opportunity that the problem will be solved in the near future?
3. The velocity of a moving object can change as it speeds up, slows down or changes the direction of motion.
4. I insist that you should tell us what the real reason is.
5. Nobody objected that he would be appointed head of the department.
6. I see no reason why you should not sign the agreement.

7. They took a decision to reduce their expenses because they wanted to save money.
8. I do not like when you speak like this.
9. We know that the house was destroyed by a stroke of lightning.
10. The fact that I had failed merely made me try again.
11. Satellites travel successfully in case they have been set on a proper orbit.
12. I was surprised that she omitted very important details.
13. There is a chance that I get this job.
14. His friends grew tired because he pretended to be someone he was not.
15. We know that the input signal is perfectly reproduced at the output of an amplifier.
16. You can rely on them as they always keep their promise.

4. State whether the *ing*-form is a gerund, a participle or a verbal noun.

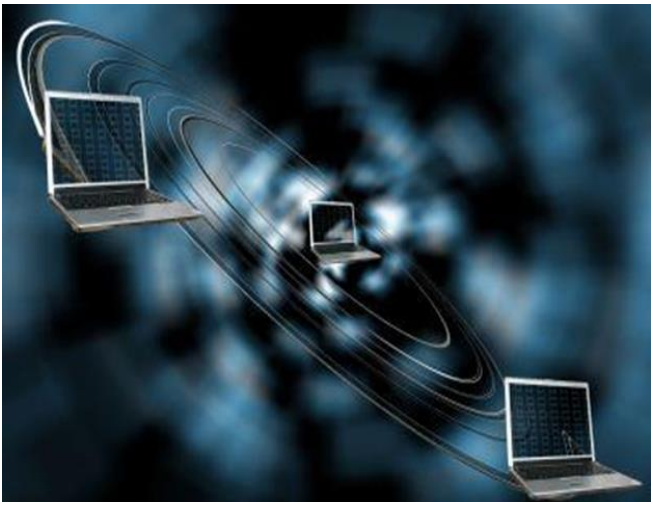
1. In their investigation, researchers applied a device for converting an optical image into an electrical signal.
2. While working at a new transmitter for deaf people, Bell invented a telephone.
3. In the past few years, technology has radically changed our ways of living and working.
4. I like reading science-fiction books because the reading of such books develops my imagination.
5. Moving through the magnetic field, the coil of wire cuts the lines of force.
6. The key in life is setting goals.
7. We are surprised at your having not known about it before.

8. Being properly adjusted, the machine works efficiently.
9. The sharing of information is the core of the Internet.
10. Being rather absent-minded, he tends to forget things.
11. Being absent-minded can cause serious troubles.
12. Not wanting the responsibility of deciding I tossed a coin.
13. Measuring any quantity means comparing it with an accepted unit for that quantity and finding out how many times it is larger or smaller than the standard unit is.
14. In two or three years with the proper coaching, she could be brought up to university standard.
15. Being ambitious, he hopes to get promotion.
16. Being ambitious is the driving force to success.
17. The subject of electricity divides into electrostatics dealing with electric charges at rest and current electricity treating the flow of charge along wires.
18. Ultraviolet light is far more effective in generating chemical reactions than visible light.
19. Batteries offer the dual advantage of having no moving parts and of converting chemical to electrical energy without the need to reject much energy.
20. The applications of control systems cover a very wide scope ranging from the designing of precision control devices to the designing of the equipment used for controlling some industrial processes.

UNIT 3 Wireless vs Wired

Lead-in

1. It was not so long ago that "wireless technology" invoked thoughts of bricklike cellular phones. Nowadays wireless technologies have become the desired connectivity for users in places as diverse as corporate offices to schools due to their flexibility and ease of deployment. The term "wireless" refers to a variety of technologies and devices from computers and smartphones to headphones and speakers that apply one or more techniques to convey data.



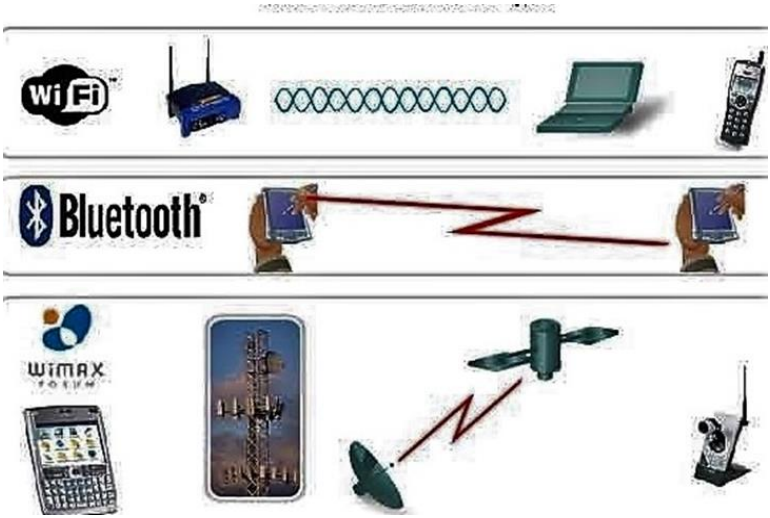
Work in pairs and make a list of wireless technologies that are available nowadays.

2. Work with another pair and compare your lists. Are they similar or different? Decide whose list is the most complete.

3. Work in groups and brainstorm features of a wireless system that are vital for users to meet their requirements.

4. Compare your ideas with those of other students. Do your views coincide or contradict?

5. Summarize your ideas and agree on the key aspects due to which wireless technologies have become ubiquitous.



Vocabulary

1. Wireless technology is related to telecommunications in which electromagnetic waves rather than some form of wire or any other forms of electrical conductors carry the signal over part or the entire communication path. This area involves a range of special terms and concepts.

These are some basic terms used in relation to wireless technologies. Match the terms with the definitions on the right.

1. broadband connection	**A** The internetworking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable

	these objects to collect and exchange data.
2. AES encryption (Advanced Encryption Standard)	**B** The amount of data transferred in one direction over a link divided by the time taken to transfer it, usually expressed in bits or bytes per second.
3. mesh network	**C** The technology that allows machines to communicate with other machines through a wireless network.
4. DSL (Digital Subscriber Line)	**D** Any wide area network (WAN), such as the Internet, or any local area network (LAN) that uses the special protocol. It is the global networking standard.
5. duty cycle	**E** A communications medium capable of transmitting a relatively large amount of data over a given period, a communications channel of high bandwidth.
6. data transfer rate	**F** A communications technology where a signal is transmitted over a broad range of frequencies and then reassembled when received.
7. latency	**G**A communications network in which there are at least two pathways to each node. If one of the paths fails, the other is still available.

8. The Internet of Things (IoT)	**H**A technology that increases the digital capacity of ordinary telephone lines (the local loops) into the home or office for Internet and TV service.
9.TCP/IP network (Transmission Control Protocol/Internet Protocol)	**I** The National Institute of Standards and Technology's replacement for the Data Encryption Standard (DES). It currently supports 128, 192 and 256-bit keys and encryption blocks, but may be extended in multiples of 32 bits.
10. spread spectrum	**J** The product of the pulse duration and pulse repetition frequency of a pulse carrier, equal to the time per second that pulse power is applied.
11 M2M (machine to machine)	**K** The time it takes for a packet to cross a network connection from sender to receiver.

2. Complete the text by inserting the words from the box in the gaps.

ISM band wired connection broadband systems range

data rates local-area network power consumption

Primarily associated with computer networking, Wi-Fi uses the IEEE 802.11 specification to create a wireless 1)…. Usually a Wi-Fi network consists of a 2)… to the Internet, leading to a wireless router that

transmits and receives data from individual devices, connecting them not only to the outside world but also to each other. Wi-Fi 3)… is generally wide enough for most homes or small offices, and for larger campuses or homes, special extenders may be placed strategically to extend the signal. Over time, the Wi-Fi standard has evolved, with each new version faster than the last.

Bluetooth vs Wi-Fi

Bluetooth and Wi-Fi are both wireless communication protocols and even share some frequencies under the 4)…. However, there is a significant difference between these two technologies in terms of range, 5)…, applications. Maximum operating range for Bluetooth is 10m while that for Wi-Fi is around 100m. Bluetooth uses a 6)… with a maximum range of 50 feet, but with sufficient speed to enable transmission of high-fidelity music and streaming video. Bluetooth provides easy connectivity between devices and consume less power but is less efficient in terms of 7)… and data exchange speeds. On the other hand, Wi-Fi set-ups are complicated and consume higher amount of power but are secure and provide higher data exchange speeds.

WiMAX

Dedicated wireless 8)… offer fast Web surfing without connecting to cable or 9)…. One well-known example of wireless broadband is WiMAX. Although WiMAX can potentially deliver 10)… of more than 30 megabits per second, providers offer average data rates of 6 Mbps and often deliver less, making the service significantly slower than hard-wired broadband. The actual data rates available to someone using WiMAX can vary widely with their distance from the transmitter. WiMAX is also known as one version of 11)… and has been available in phones as Sprint's 4G technology. Recently, the company has started building out a network using 4G 12)….

Reading

1. Work in pairs. You are going to read an article about the most popular types of wireless technology. One partner should read about ZigBee and Wi-Fi technologies, another – about Bluetooth and WiMax.

While reading the article, highlight the key features of each technology and answer the questions.

1. What is the purpose of technology?
2. What benefits does the technology provide?

2. Take turns to talk about the technologies focusing on the questions above.

Five Types of Wireless Technology

Various types of wireless technology allow devices to communicate (send data) to each other and to the web (TCP/IP Networks) without cables and can be implemented in hardware products for the Internet of Things (IoT) and Machine-to-Machine (M2M) communication.

The Institute of Electrical and Electronics Engineers (IEEE), a professional association and an authority for electronic communication sets standards for common types of wireless technologies. Each IEEE protocol has its own distinctive advantages and limitations. However, promising developments expand their potential applications.

IEEE 802.15.4: What is ZigBee?

A wireless technology currently gaining popularity, ZigBee is an open global standard and is designed specifically for M2M networks. The technology is inexpensive to run and does not require much power making it an ideal solution for industrial applications. It has a low latency, and a low duty cycle, allowing products to maximize battery life.

The ZigBee protocol offers 128-bit AES encryption. The technology is also used in Mesh networks to connect nodes through multiple pathways. There are prospects of its implementing in smart home devices. The technology's ability to connect multiple devices simultaneously enables a connected home environment, with things like smart locks, lights and robots talking to one another. With current ZigBee devices, smart home is not feasible. However, the ZigBee Alliance standardized the technology to make the connectivity possible.

IEEE 802.11: Wi-Fi

Wi-Fi uses radio waves (RF) to allow two devices to communicate with one another. Wi-Fi can utilize both the global 2.4GHz UHF and 5GHz SHF ISM radio bands.

Under the IEEE Wi-Fi standards, the available frequency bands are split into several separate channels. Since these channels overlap in frequency, Wi-Fi uses channels that are far apart. Within each of these channels, Wi-Fi uses a "spread spectrum" technique in which a signal is broken into pieces and transmitted over multiple frequencies. Spread spectrum enables the signal to be transmitted at a lower power per frequency and multiple devices to use the same Wi-Fi transmitter. Because Wi-Fi signals are transmitted over short distances (usually less than 100 meters) in indoor environments, the signal can reflect off walls and other obstacles, thus arriving at multiple time intervals and causing a problem called multipath interference. Wi-Fi reduces multipath interference by combining three different ways of transmitting the signal (in a method developed by Australian engineer John O'Sullivan and collaborators).

Wi-Fi can provide wireless broadband Internet access for modern devices, such as laptops, smartphones, tablet computers, and electronic gaming consoles. Wi-Fi-enabled devices are able to connect to the Internet when they are near areas that have Wi-Fi access, called "hot spots." Hot spots have become common, with many public places such as airports, hotels and coffee shops offering Wi-Fi access. Some cities have constructed free citywide Wi-Fi networks. A version of Wi-Fi called Wi-Fi Direct allows connectivity between devices without a LAN.

IEEE 802.15.1: Bluetooth and BLE

Bluetooth and Bluetooth Low Energy (BLE) are wireless technologies used to transfer data over short distances. The technology is used in devices that connect to phones and tablets, e.g. in speaker systems. Bluetooth uses UHF radio waves for data transfer. Bluetooth Low Energy uses less power than standard Bluetooth and is available in hardware such as fitness trackers, smart watches and other

connected devices to transmit data wirelessly without heavily reducing the battery power in a user's phone.

BLE was initially introduced by smartphone maker Nokia in 2006, but became part of Bluetooth standard only in 2010. Today, BLE, which is also referred to as Bluetooth Smart, is supported by the majority of smartphone and computer makers as well as most major operating systems including Windows 8, OS X, Linux, Windows Phone, Android and iOS.

IEEE 802.16: WiMax

WiMax, which stands for Worldwide Interoperability for Microwave Access, is communication technology for wirelessly delivering high-speed Internet service to large geographical areas.

Part of a "fourth generation" (4G) of wireless-communication technology, WiMax far surpasses the 30-metre (100-foot) wireless range of a conventional Wi-Fi local area network (LAN), offering a network with a signal radius of about 50 km (30 miles).

WiMax operates over radio waves on a tower-receiver model. A single WiMax tower can provide coverage over about 8,000 square km (3,000 square miles) and connect to other towers via a line-of-sight microwave link to broaden coverage further. A roof-mounted antenna dish can receive information at the fastest data-transfer rates, or an internal receiver chip in a personal computer, mobile telephone, or other device can communicate without a line of sight at lower speeds. Under optimal conditions, WiMax offers data-transfer rates of up to 75 megabits per second (Mbps), which is superior to conventional cable-modem and DSL connections. In practice, speeds are lower since the bandwidth is split among multiple users.

The development of WiMax began in the early 21st century, with the American integrated circuit manufacturer Intel Corporation investing in creating receiver chipsets. Several mobile carriers, notably Sprint, used the technology to deliver wireless data to their customers. Sprint, along with other carriers, has since switched over to using faster LTE 4G networks.

Comprehension

1. Find words in the text with the following meaning.

1. To give an opportunity to do something, to make something possible to do.
2. To make something such as a system start to work and be used.
3. Easy to recognize because of being different from other things of the same type.
4. To get more of something, usually as a result of a gradual process.
5. A machine that uses advanced technology to make it effective and intelligent.
6. To divide something into smaller parts.
7. A situation when some aspects are shared by more than one object.
8. The right or opportunity to have or use something to benefit from.
9. To bring something into existence or use for the first time.
10. To make something smaller or less in size or amount.
11. To make information or service available.
12. Of the usual, traditional, or accepted type, instead of being new and different.
13. To be better or greater than something else.
14. To change from one thing to another.

21. The text contains a number of collocations (fixed expressions). Match words in A with words in B to make collocations and use them to complete the sentences below.

A	B
industrial	band
set	connection
home	distance
frequency	cycle
gain	access
short	standard
DSL	application
battery	rate
Wi-Fi	pathway
data-transfer	life
duty	environment
multiple	popularity

1. The ZigBee technology is ideal for a connected…since it allows connecting multiple devices simultaneously.
2. Bluetooth and BLE are efficient when one needs to transfer data over a….
3. According to Wi-Fi standards, the available…are divided into several separate channels.
4. A wireless technology, which is currently…, is ZigBee designed for M2M networks.

5. WiMax features…of up 75 Mbps, which is much faster than conventional modem and….
6. The responsibility of IEEE task groups is to…for common types of wireless technologies.
7. The ZigBee advantages such as a low latency and a low…enable to extend….
8. Special areas known as hot spots provide… and make it possible for Wi-Fi-enabled devices to connect to the Internet.
9. ZigBee is also applied in Mesh networks connecting nodes through….
10. ZigBee is a perfect solution for…because the technology is cheap and power efficient.

3. Which is the correct answer in each case?

1. Wireless technology enables high-speed data transfer over distances using

a) nuclear energy

b) charge carriers

c) electromagnetic waves

2. Why is the ZigBee technology gaining popularity?

a) because it is cheap and consumes much power

b) because it is cheap and power efficient

c) because it is cheap and compatible with other protocols

3. What are advantages of a spread spectrum technique?

a) It allows broadcasting using one transmitter.

b) It allows transmitting over long distances.

c) It allows low power transmission and the possibility of using the same Wi-Fi transmitter by multiple devices.

4. How does Wi-Fi reduce multipath interference?

a) by using multiple transmitters

b) by amplifying signals

c) by combining three different ways of transmitting a signal

5. One of the Wi-Fi applications is providing

a) wireless broadband Internet access for electronic gadgets

b) control over automated industrial processes

c) identification

6. Bluetooth Low Energy (BLE) or Bluetooth Smart is implemented in modern smartphones and computers because

a) it is less expensive than standard Bluetooth

b) being more power efficient than standard Bluetooth, it allows saving battery power

c) it provides coverage of large areas

7. Being part of the 4G wireless technology, WiMax surpasses a conventional Wi-Fi LAN coverage in

a) range and data-transfer rate

b) cost and complexity

c) the number of devices sold

Reading 2

1. Wireless technology is considered as one of the greatest technological contributions to the society since it offers a range of unique advantages. On the other hand, there are limitations that might affect the performance of a system and should be taken into consideration while deciding on the appropriate technology for a particular application.

Work in groups of four and brainstorm advantages of wireless technology over a wired connection (think of a range and data-transfer rate, power consumption and security).

2. Work with another pair and compare your views. Discuss limitations of both connections.

3. To check your ideas read the text below.

Wired vs. Wireless Connectivity

In wired connections, signals are sent from mice, keyboards and other peripherals using electrical impulses transported over a series of conductive wires. Information is transferred at high speeds with consistent reliability. Although the transmission appears instantaneous, there is a slight delay before the computer receives the signal that leaves the device. However, this delay is so short that it often remains unnoticed. During transport, the signal is susceptible to interference from other electrical sources such as nearby power cabling and electric motors. To reduce the risk of interference, wires are protected e.g., by a magnetic foil. The type of shielding used in a cable depends on the amount of protection needed. Although cabling is a reliable and high bandwidth method of connectivity, it is not without limitations. Installing a cable for every desktop connection can clutter a workspace and leave a messy appearance. Cabling also restricts a user's mobility.

Wireless technologies such as 802.11, also known as Wi-Fi, provide the convenience of connecting to Internet accessible networks for web browsing and file sharing without the need for cabling. In a Wi-Fi environment, users have the freedom to move around while remaining connected. Wi-Fi is widespread since Wi-Fi access sites are provided in public places such as airport lounges and coffee shops.

Wireless communications offer the benefit of increased mobility and flexible device placement. Working professionals can access Internet anywhere and anytime without carrying cables or wires. This results in improving the productivity. Urgent situations can be alerted and the affected regions can be provided with help and support through wireless communication. Moreover, wireless networks are cheaper to install and maintain.

Similar to cabling, wireless technology has some drawbacks. In wireless connections, signals are transmitted by radio waves propagated through the air, therefore, signals are not received instantaneously. Radio waves not having a precise path between devices, the amount of delay is noticeable with certain desktop connections. Wireless

technologies use an error correction method called "buffering" that stores the incoming information and waits until all data is present before outputting to a device. This method is efficient for slide show and video applications; however, the delay is too significant for most desktop purposes.

Since a wireless connection travels through the air, shielding is not possible, making signals susceptible to interference from other RF devices and power sources. Among the other critical drawbacks of wireless technology are range, power drain and security.

Wi-Fi networks have limited range. A typical Wi-Fi home router using 802.11b or 802.11g with a stock antenna might have a range of 32 m indoors and 95 m outdoors. Range also varies with frequency band. Although you lose the wires, you are still limited to the base station's range, typically 75 to 150 feet indoors and a few hundred feet outdoors, depending on equipment, radio frequency, and obstructions. Some versions of Wi-Fi technology feature high power consumption – a disadvantage for battery-dependent laptop users.

Wherever wireless connection is concerned, security is a major issue. Outsiders can get into wireless networks and easily grab wireless signals spread in the air. This increases the risk of losing information. It is vital to secure the wireless network so that unauthorized users cannot exploit information. The Wi-Fi Alliance currently recommends using Wi-Fi Protected Access (WPA) technology, which both authenticates users and encrypts data.

Comprehension

1. Match up the words below into pairs that have similar meaning.

transfer restrict store
susceptible improve
accessible reduce
connect messy provide
noticeable remain limitation
consistent significant

drawback enhance
constrain decrease offer
perceptible available link
crucial transport untidy
stable stay
vulnerable keep

2. Complete the sentences to summarize the text.

1. Wired and wireless connections differ in…
2. Wires are protected in the wired transmission because…
3. The limitations of wired connections are…
4. The major benefits from using wireless technology are…
5. Buffering is applied…
6. The most critical drawbacks of wireless technology are…
7. To secure the wireless network is vitally important because…

Language Focus

1. Read the text about Wi-Fi networking and choose the correct form in each case.

Wi-Fi Protocol: Networking and Attributes

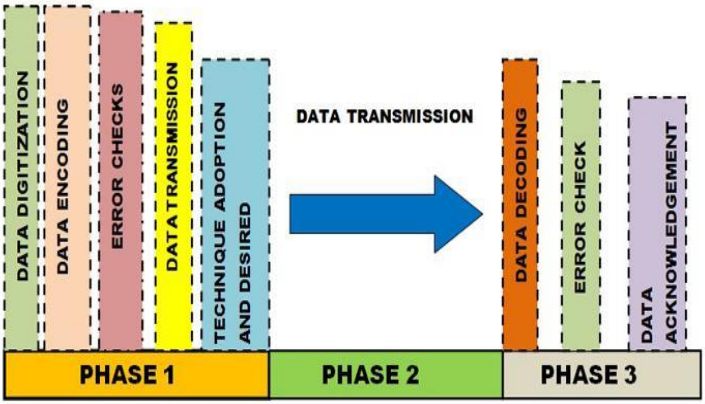
(0)<u>*Being*</u>*/Been* a wireless protocol, Wi-Fi standard uses the ISM (Industrial, Scientific and Medical) band of frequency, which is free and *1) does not require/require* no licensing. Launched in 2.4GHz with transmission rates of 1-2mbps, Wi-Fi now works at 5GHz frequency with data transmission rates *2) reaching/reached* up to 54mbps at both frequencies.

Wi-Fi is a marketing term *3) applying/applied* to 802.11b IEEE standard, but now it is used for all the standards that fall *4) over/under* 802.11 category of Wireless LAN. Popular Wi-Fi version are a, b, g and n.

The idea of fast speed wireless LAN originated when the United States Federal Communications Council, a communication agency of the US government, decided in 1985 to utilize a few bands of wireless spectrum *5) without/with* subjecting them to a license fee. Following this, in 1990 IEEE founded the committee for 802 standards, with Victor Hayes, Father of Wi-Fi appointed its head. Using the license free bands (now being termed as ISM bands) and *6) collaborating/being collaborated* with networking giants such as Nokia, Motorola, etc. the committee introduced WLAN legacy of Wi-Fi in 1997. To maintain the

quality of service Wireless Ethernet Compatibility Association (WECA) was set up in 1999. In 2002,it *7) had become/became* Wi-Fi alliance. This trade organization is responsible for testing gadgets that claim*8) to be fulfilling/to fulfill* the criteria of Wi-Fi based networking. Started by a few companies like Nokia, Motorola, Alcatel, the association now has more than 500 networking giants that are involved *9) in/at* testing, sponsoring and working of the alliance. The alliance *10) belongs/owns* the Wi-Fi trademark and only those devices that comply with Wi-Fi standards, can get the trademark printed or engraved on their gadget.

Data *11) conversion/exchange* in Wi-Fi can be summarized into three phases:



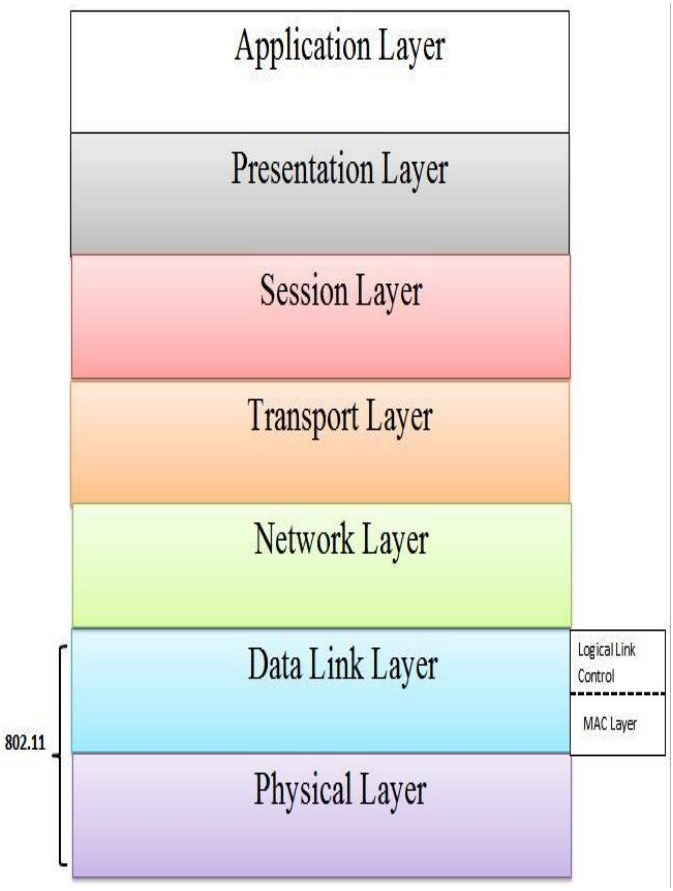
Phase I involves preparing data for transmission: encoding and changing into *12) pixels/frames*. The frequency for data transmission is also chosen depending *13) of/upon* the technique used to send the signals wirelessly.

Phase II is actual data transmission with air *14) like/as* the medium of wave propagation.

Phase III consists in receiving, decoding acknowledging and then using data.

All of these phases apply some of the digital communications spread spectrum techniques for signal multiplexing (FHSS, Infrared and OFDM etc.) and security methods (WEP, WPA).

Based on the OSI model, Wi-Fi uses various data exchange techniques, security measures, network topologies that make it a well-strategized *15) wired/wireless* network. Wireless LAN uses physical layer and MAC sub-layer (of data link layer) of the OSI model. The physical layer implements wireless data exchange and the MAC layer synchronizes data transmission.



Wi-Fi standard has been designed to be enough *16) robust/sensitive* against the interfering frequencies by other electronic gadgets such as microwave ovens etc. along with *17) having maintaining/maintaining* high data transmission speeds and ensuring data safety. Three wireless data exchange schemes adopted by physical layer in 802.11 – Infrared, Frequency Hopping Spread Spectrum Technique and Direct Sequence Spread Spectrum Technique – met these *18) requests/requirements*. Out of these techniques, infrared was soon eliminated due to range *19) benefits/limitations*. DSSS technique is effective in low to high interferences while FHSS works with high interference signals.

In 802.11, Physical Layer 20) can be *divided/dividing* into two sub-layers: Physical Layer Convergence Procedure (PLCP) and Physical Medium Dependent (PMD) Protocol. PLCP layer either analyzes the data *21) piles/packets* received or prepares them for transmission across the radio channel. PMD layer *22)both/either* demodulates the packets received or modulates the data before sending them over the channel.

Initial spread spectrum techniques of FHSS and DSSS sufficed for transmission speeds up to 1-2mbps but were *23) efficient/inefficient* at higher ones. IEEE then further provided more modulation techniques that were able to provide higher data rates. The IEEE standard update for a, b and above versions*24) included/was included* Complementary Code Keying (CCK) data modulation technique. CCK technique uses 64 code words of 8bit, which are mathematically *25) similar/unique* and are easily distinguishable at receiver end. Applying CCK technique increased the data transmission rates to 5.5 and 11mbps, respectively. Inclusions of techniques such as OFDM and MIMO-OFDM have increased the speed to 54mbps and more.

Medium Access Layer's task is to ensure reliability in data transmission through two utilities: Distributed Coordinated Function and Point Coordinated Function. Distributed Coordinated Function is a mandatory method used in 802.11standard. It utilizes Carrier Sense Multiple Sense with Collision Avoidance (CSMA-CA) technique. CSMA technique is deployed to make the source *26) to confirm/confirm* first that whether channel is free to transmit data or not. It is a contingent technique, which ideally lets only one source transmit over a channel at a particular period, thus avoiding signal collision and its consequent re-transmission. After a frame is sent, the transmission in channel ceases

for a period*27) called/calling* inter-frame space (IFS). In case, multiple channels are to transmit at the *28) different/same* time, a priority algorithm is applied to avoid transmission conflict. To aid the stations in determining the time when channel would be occupied, a network allocation vector (NAV) is used. This vector suggests the time for which current data transmission is occurring and when a source can check the channel again to send data.

2. It is widely believed that the 21st century is the era of wireless technology. Do you think the same way? Discuss with your partner.

3. The article below is about advances in wireless technology. Read the text quickly without paying attention to the gaps and find the reasons the author gives in favour of the popular opinion.

4. Complete the text by filling in an appropriate word in each space. You need to use "grammar" words: articles, conjunctions, prepositions, auxiliary verbs, pronouns. There is an example at the beginning (0).

Examining the Future

In a couple of decades, Wi-Fi has evolved *(0) from* sluggish connections to an incredibly versatile technology. Because it plays an integral role in the lives of millions of people, it is 1)… improved almost constantly.

In 1997, the IEEE released the base standard 2)… wireless local area network (WLAN) communications called 802.11. In the years following, many amendments were made to this standard to enhance communication.

In 2007, 802.11n offered the drastic improvement in transfer rate speed – 300-450 mbps, depending 3)… the number of antennas – and range. This was the first main protocol that operated on 4)… 2.4 GHz and 5 GHz. These transfer rates allow large amounts of data to be transmitted more quickly 5)… ever before.

In 2013, 802.11ac was introduced. AC was the first step in what is considered "Gigabit Wi-Fi". It offers speeds of nearly one gbps that is roughly 20 times 6)… powerful than 802.11n, 7)… makes it an important (and widely used) new protocol. AC runs on a 5 GHz band,

which is important, because it is less widely used, you have an advantage as far as high online speeds are concerned, 8)… the higher frequency and higher modulation rate mean the range is more limited.

Since consumers and companies are looking 9)… two things in particular – incredible range and extreme speed, three wireless network options 10)… expected in the near future: 802.11ah (low data rate, long-range sensors and controller Wi-Fi), 802.11af (or "White-Fi", as it uses unused TV spectrums for long-range transmission), and 802.11ad (the non-wired multi gigabit high-performance networking Wi-Fi).

802.11ah is 900 megahertz Wi-Fi, which is ideal for low power consumption and long-range data transmission. It 11)… penetrate through walls and obstructions better than high frequency networks like 802.11ad 12)… consuming much power. This would be applicable in smart building applications, like smart lighting, smart HVAC, and smart security systems. It would also work for smart city applications, 13)… parking garages and parking meters. 14)…, AH is not available yet. There is no global standard for 900 MHz. Right now, 80% of the world uses 2.4 GHz Wi-Fi. The IEEE is in the final phases of resolving the standard. Then the chip manufacturers (like HUAWEI, Broadcom, and Qualcomm) will start creating physical layer chips.

802.11af utilizes unused television spectrum frequencies (i.e., white spaces) to transmit information. 15)… these frequencies are between 54 MHz and 790 MHz, AF can be used for low power, wide-area range providing high data rates. The standard is still in proposal stages and has not 16)… approved or released to the mass market yet. Moreover, "white space" channels are not available everywhere, like in big cities.

802.11ad is ideal for very high data rate, very short-range communications.

AD Wi-Fi separates 17)… from the 2.4 GHz and 5 GHz bands and operates on a 60 GHz band. This space is completely free and open, which helps it achieve speeds that are 50 times faster than Wi-Fi N. While AH uses 900 MHz, AD uses 60 GHz. Being so fast, this protocol has the potential to enable a new class of devices. Currently AD (which operates on a 60 GHz band) is not a recognized international standard. The chips are very expensive to manufacture, which makes this a costly set up.

These three amendments are clear evidence that Wi-Fi 18)… undergone a spectacular transformation so far.

/60GHz wireless deployment for transmission of high definition audio and video in a home theater/.

Another wireless solution recently introduced 19)… the computer and audio/video markets is Ultra Wideband (UWB). UWB has the advantage of achieving a fast data rate of 480mbps. This makes it ideal for low bandwidth signal distribution such as VGA connectivity. UWB does not require buffering of incoming data, which makes it a great solution for real-time applications 20)… transmitting a slide presentation from computer to display, or sharing non-graphic intensive documents and materials. However, UWB is limited in range and lacks 21)… ability to penetrate walls. Most wireless solutions using this technology require that the source device and display be located no more than 30ft apart.

Because UWB operates in a frequency range 22)… 3.1GHz… 4.8GHz, it will not interfere with Wi Fi used for networking. Most UWB devices utilize a PIN association 23)… the transmitter and receivers. This means that multiple UWB devices can be used in the same proximity and will not interfere with each other. This provides added security and streamlined operation where multiple wireless devices may be used in the same area or close to each other.

UWB wireless deployment for presentation sharing in a conference room.

5. The text below is about Bluetooth, one of the wireless technologies that attracts more and more users worldwide. Seven sentences have been removed from the text. Choose from the sentences (A-H) the one, which fits each gap. There is one extra sentence you need not use.

Bluetooth® technology is the global wireless standard enabling convenient, secure connectivity for an expanding range of devices and services.

In 1994, a team of researchers from Ericsson Mobile, a Swedish company, carried out a feasibility study on low power wireless connectivity to eliminate cable, which later developed into Bluetooth technology. **1)** _____.

The name "Bluetooth" comes from the 10th century Danish King Harald Blåtand or Harold Bluetooth in English. King Blåtand helped unite warring factions in parts of what are now Norway, Sweden and Denmark. Similarly, Bluetooth technology was created as an open standard to allow connectivity and collaboration between disparate products and industries.

2) _____. The technology operates in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.485 GHz, using a spread spectrum, frequency hopping, full-duplex signal at a nominal rate of 1600 hops/sec. The 2.4 GHz ISM band is available and unlicensed in most countries.

The effective range of the device is around 10 meters, whereas the high-powered Bluetooth will enable range of 100m. **3)** _____. Power consumption in Bluetooth is low as compared to other devices such as Wi-Fi. Bluetooth radios draw 0.3mA in stand-by mode and 30mA during the data transmission. Each subsequent Bluetooth version offers increased transfer rate, with the rate reaching up to 3 Mbps in version 2.0 compared to one Mbit/s in version 1.2.**4)** _____. This will allow for a very fast data transfer of up to 480 Mbit/s.

Communication occurs automatically between the Bluetooth enabled devices that come within their range. **5)** _____.Each Bluetooth enabled component, e.g. a mobile phone or personal computer, forms their own Piconet. All of the devices have their own range of addresses. A computer sends signals to other devices requesting responses with an address. A mobile phone with the address responds and establishes a network. Even though it receives signals from the other systems, it ignores it, as it does not belong to the same network.

6) _____.The applications of Bluetooth include wireless networking between computers or computers and mobile phones, wireless communication between computer input and output devices, wireless control and communication between mobile phone and hands free headset.

Originally intended to be a wireless replacement for cables on phones, headsets, keyboards and mice, Bluetooth technology now goes far beyond that. **7)** _____. Future of the Bluetooth technology lies in providing quality of service, enabling high quality audio and video data transfer, providing greater bandwidth and greater distance in a highly secure environment.

A. Bluetooth uses short-range radio frequency (RF) technology to exchange data over short distances.

B. Once the network is established and conversation takes place they create a Personal-Area Network (PAN), commonly known as Piconet.

C. Bluetooth technology is already widely used in the industry due to its ability to handle both voice and data transmission simultaneously.

D. Each Bluetooth enabled device can communicate with up to seven other devices within its transmission radius.

E. Bluetooth wireless technology is built into billions of products, from cars and mobile phones to medical devices and computers and even toothbrushes.

F. Mobile phones, FM radio and television all use radio waves to send information wirelessly.

G. In September 1998, the original group of promoter companies – Ericsson, IBM, Intel, Nokia and Toshiba – founded the Bluetooth Special Interest Group (SIG).

H. According to the new specification, Bluetooth 3.0 will adopt ultra-wideband (UWB) radio technology.

Speaking

1. Work in two groups.

Group A: You are designers of an innovative wireless system. You have been invited to participate in an international exhibition on advanced electronics. Be prepared to demonstrate your device and answer visitors' questions.

Group B: You are visitors at an international exhibition. One of the exhibits – a novel wireless device – is of particular interest to you. Ask designers to demonstrate its operation and overview its performance and features.

Role-play your sessions.

2. Prepare a presentation of a device to promote it to the market.

Writing

1. Write a report analyzing advantages and limitations of wireless technology. In your report, make some suggestions and recommendations on criteria and features a user should take into consideration when choosing a wireless device.

Summary Writing

A summary is the representation of the content of a piece of writing (e.g. a scientific article) in a condensed form. A summary comprises the most important information presented in the original work excluding

the details. A summary should have a clear structure. It usually consists of three parts:

- The introduction (the author's name, the title of the article, the printed source, the date of publication).
- The main part (statements generalizing the main ideas of the original in a logical sequence).
- The conclusion (the author's conclusions, opinions, suggestions, comments; recommendations for readers).

To describe the author's ideas a summary should include formal expressions, clichés and linking words.

The introductory phrases:

1. The article deals with . . . (speaks about, presents, shows, discusses, describes, gives an accurate description of, covers, considers, reviews, gives some comments on, traces the history of, outlines the development of, offers an overview).
2. As the title implies the article describes. . .
3. The article consists of (contains, includes, falls into) 3 (4…) parts (sections).
4. The subject (topic, theme) of the article is . . .
5. The purpose (aim) of the article is to provide . . .
6. The article aims to provide (to acquaint, to present, to show) . . .
7. The author of the article is a well-known (distinguished, outstanding, prominent) scientist in the area (sphere, field) of …
8. The author is a Nobel Prize winner (State prizewinner).
9. The article provides the reader with some data (material) on . . .

10. The article gives a valuable information on (a detailed analysis of . . .)

The phrases for the main part:

1. The author/article points out/emphasizes/stresses
2. The author suggests/assumes/claims that . . .
3. It is specially noted that . . .
4. It is reported that . . .
5. It is spoken in detail about . . .
6. A mention should be made that . . .
7. Much attention is given to . . .
8. The author/article draws/attracts the reader's attention to . . .
9. The article includes a number of illustrations. The article is profusely illustrated with graphs/ diagrams/tables/photographs.

The concluding phrases:

1. Finally, the author concludes/assumes that
2. In conclusion (in summary, summarizing, summing up) the author emphasizes/stresses that
3. The article is of great help/of interest to students (engineers, etc.).
4. The article is addressed/recommended to undergraduates (postgraduates, scientists, designers, etc.; a wide range of readers).

The main requirements for a summary are the following:

1. The summary should cover the original as a whole.
2. The material should be presented in a neutral fashion.

3. The summary should be a condensed version of the original presented in your own words.
4. You should not include anything that does not appear in the original. (Do not include your own comments or evaluation.)
5. Be sure to identify your source.

To write a good summary it is important to understand the material you are working with thoroughly. Here are some preliminary steps in writing a summary.

1. Skim the text focusing on subheadings. If there are no subheadings, try to divide the text into sections. Determine what type of text you are dealing with and try to identify important information.
2. Read the text highlighting important information and taking notes.
3. In your own words, write down the main points of each section.
4. Write down the key support points for the main topic, but do not include minor detail.

Example

Global Implications of Patent Law Variation

A patent is an exclusive right to use an invention for a certain period of time, which is given to an inventor as compensation for making an invention. (*This first sentence is a general definition. It may be safe to assume that your audience is already familiar with patents; thus, you do not have to include it in your summary.)*
Although it would be beneficial for the world economy to have uniform patent laws, each country has its own laws designed to protect domestic inventions and safeguard technology. ***(This is the main idea.)***
Despite widespread variation, patent laws generally fall under one of two principles: the first-to-file and first-to-invent. *(The classification of the two principles is important.)*
The first-to-file principle awards a patent to the person or institution that applies for a patent first, while the first-to-invent principle grants the patent to the person or institution that was first to invent – and can

prove it.*(Ignore specific details about the different principles. The terms are self-explanatory.)*

Most countries have adopted the first- to-file system. However, the United States maintains a first-to-invent system, despite obvious shortcomings. *(It is important to point out that most of the world follows one system and the United States another.)*

A result of employing different patent law principles is inconsistency of patent ownership. *(Include a description of the problem surrounding variation in patent laws.)*

Patent ownership is not recognized globally. *(Provide some support/explanation for the problem, but not all the details.)*On the contrary, ownership may change depending on the country. It is typical of an invention to have two patent owners – one in the United States and one in the rest of the world. This unclear ownership often has economic consequences. If a company is interested in using a patented invention, it may be unable to receive permission from both patent owners, which in turn may prevent manufacture of a particular product. Even if permission is received from both owners, pay royalties to both may be quite costly. In this case, if the invention is useful enough, a company may proceed and pass on the added cost to consumers.

This situation may cause the international tension. Many foreign individuals and companies believe that they are at a serious disadvantage in the United States with regard to patent ownership in establishing first-to-invent status. Further, failure of the United States to recognize patent ownership in other countries is in violation of the Paris Conventions on Industrial Properties, which requires all member nations to treat all patents equally. *(Describe another problem associated with differing patent principles. Provide some explanation, but not all the details.)*

The conflict surrounding patents has prompted the World Intellectual Properties Organization (WIPO) to lobby for universality in patent laws. WIPO maintains that the first necessary step involves compelling the United States to reexamine its patent principle, taking into account the reality of a global economy. *(Describe the action taken to solve the problem.)* This push may result in enhancing global economic cooperation.

In his paper “Global Implications of Patent Law Variation,” Koji

Suzuki states that lack of consistency in the world's patent laws is a serious problem. In most of the world, patent ownership is given to the inventor that is first to file for a patent. However, the United States maintains a first-to-invent policy. In view of this, patent ownership can change depending on the country. Multiple patent ownership can result in economic problems; however, most striking is the international tension it causes. The fact that the United States does not recognize patent ownership in other countries, in violation of the Paris Convention on Industrial Properties, has prompted the World Intellectual Properties Organization (WIPO) to push the United States to review its existing patent law principles.

1. Read the article below and

a) state the purpose of the research;

b) highlight the results of the research;

c) identify the main points in each paragraph of the article.

Engineers Achieve Low Power Wi-Fi

The upside of Wi-Fi is that it is widespread, invisibly connecting laptops to printers, allowing smartphones to make calls or stream movies without cell service. The downside is that Wi-Fi consumes a significant amount of energy, draining the batteries on all those connected devices.

Now, a team of computer scientists and electrical engineers at University of Washington has demonstrated that it is possible to generate Wi-Fi transmissions using 10,000 times less power compared to conventional methods. The novel Passive Wi-Fi system also consumes 1,000 times less power than existing energy-efficient wireless communication platforms, such as Bluetooth Low Energy and ZigBee. MIT Technology Review has recognized the technology as one of the 10 breakthrough technologies of 2016.

Passive Wi-Fi can transmit Wi-Fi signals at bit rates of up to 11 megabits per second that can be decoded on any of the billions of devices with Wi-Fi connectivity. These speeds are lower than the maximum Wi-Fi speeds but 11 times higher than Bluetooth. Aside from saving battery life on today's devices, low-power wireless

communication will enable an "Internet of Things" reality where household devices and wearable sensors can communicate using Wi-Fi without worrying about power.

To achieve such low-power Wi-Fi transmissions, the team essentially decoupled the digital and analog operations involved in radio transmissions. In the last 20 years, the digital technique has become extremely energy efficient, but the analog components still consume much power.

The Passive Wi-Fi architecture assigns the analog, power-intensive functions – like producing a signal at a specific frequency – to a single device in the network that is plugged into the wall. An array of sensors produces Wi-Fi packets of information using very little power by simply reflecting and absorbing that signal using a digital switch.

In real-world conditions on the UW campus, the team found the passive Wi-Fi sensors and a smartphone can communicate even at distances of 100 feet between them.

Because the sensors are creating actual Wi-Fi packets, they can communicate with any Wi-Fi enabled device. "Our sensors can talk to any router, smartphone, tablet or other electronic device with a Wi-Fi chipset," said co-author and electrical engineering doctoral student Bryce Kellogg. "The cool thing is that all these devices can decode the Wi-Fi packets we created using reflections so you don't need specialized equipment."

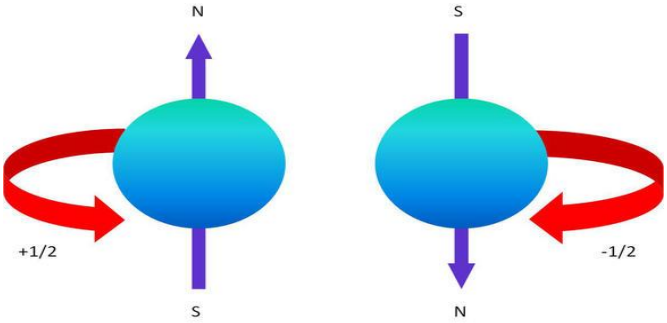
The technology could enable entirely new types of communication that have not been possible because energy demands have outstripped available power supplies. It could also simplify our data-intensive worlds.

2. Write a summary of the article.

UNIT 4 New Challenges of Spintronics

Lead-in

1. The emerging field of spintronics opens new exciting horizons in science and technology by enabling highly efficient electronics.



What do you know about this promising area? Working individually decide which of the statements below are probably true and which ones are probably false.

1. Spintronics aims to exploit the charge of an electron rather than its spin to process, transfer and control signals.

2. The term "spintronics" stands for spin transport electronics.

3. Any electron moving under the influence of an external magnetic field introduces a specific spin polarization, which reverses when the external magnetic field reverses direction.

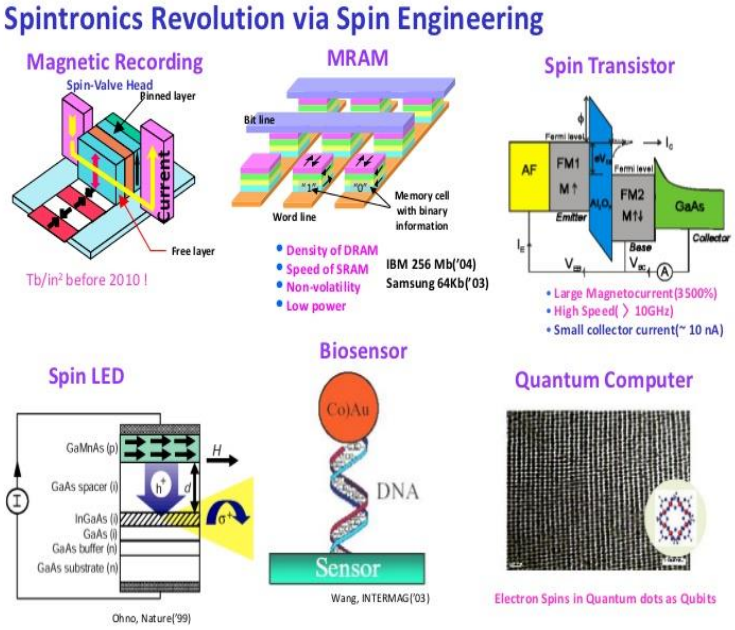
4. There are three directions for spin polarization defined as "spin back-and-forth", "spin up" and "spin down".

5. Using spins as bits of information is the key concept to operation of spintronic devices, and the magnetic field is the tool for managing the device state.

2. Work in pairs. Compare your answers with those of your partner. Summarize your ideas and discuss what phenomena

spintronics investigates.

3. Work with another pair. Do you have similar or different ideas? Brainstorm areas that are likely to benefit from applying the concept of spintronics.



Vocabulary

1. The following sentences define some basic words related to spintronics. Which word is defined in each case?

1. A vector quantity that represents the product of a body's rotational inertia and rotational velocity about a particular axis.

A position **B** angular momentum **C** revolution

2. The intrinsic angular momentum characterizing each kind of elementary particle.

A spin **B** conductivity **C** charge

3. The torque exerted on a magnet when it is placed in a magnetic field perpendicular to magnetic flux density.

A electromotive force **B** strength **C** magnetic moment

4. The characteristic time for a distribution of electrons in a solid to approach to equilibrium after a disturbance is removed.

A discharge **B** inductance **C** relaxation time

5. A measure of the degree to which a conductor or semiconductor changes its electrical resistance when a magnetic field is applied.

A capacitance **B** magnetoresistance **C** superconductivity

6. The degree to which the intrinsic angular momentum of elementary particles is aligned with a given direction.

A spin polarization **B** orientation **C** location

2. Use the words from the box to complete the text below.

charge carriers	energy state	electron spin
magnetoresistance	electron charge	
data storage	power consumption	
quantum computing	magnetic materials	

The term “spintronics” usually refers to the branch of physics studying the manipulation, storage, and transfer of information by means of the **1**___ in addition to or in place of the **2**___. Conventional electronic devices rely on the transport of electrical **3**___ – electrons – in a semiconductor. Using another fundamental property of the electron, its spin, has opened up the new field of spintronics. Major advances in electron spin transport started in 1979–1980 with the discovery of low-temperature **4**___ in metallic super lattices. Later demonstrations of the “giant” effect at room temperature evolved toward application in practical devices.

Spintronics is an emerging technology that exploits the quantum propensity of the electrons to spin making use of their charge state as

well. The spin itself is manifested as a detectable weak magnetic **5**___ characterised as "spin up" or "spin down". Exploiting spin promises new logical devices as spin transistor with enhanced functionality, higher speed and reduced **6**___.

Spintronic devices feature the advantages of both**7**___ and semiconductors. They are expected to be non-volatile, versatile, fast and capable of simultaneous **8**___ and processing, while at the same time consuming less energy. Spintronic devices play an increasingly significant role in high-density data storage, microelectronics, sensors, **9**___ and bio-medical applications. Semiconductor spintronics devices combine advantages of semiconductor with the concept of magnetoelectronics. This category of devices includes spin diodes, spin filter, and spin FET.

Reading

1. You are going to read an article about spintronics, a promising branch of electronics. Before you read it, try to predict what issues will be discussed in the article choosing the statements from those given below.

1. Discovery of spin transport.
2. Features of a magnetic field.
3. Spin and its properties.
4. Approaches to developing spintronic devices.
5. The 20th century's digital revolution.
6. Spintronics perspectives.
7. Spin limitations.
8. Advantages of electron spin over charge.
9. Applications of spin transport.

Read the article to check if your predictions were right. While reading match each statement with the paragraph in which it is discussed. Some statements do not fit.

Introduction to Spintronics

A. The second half of the 20th century could be called the microelectronics era. During that 50-year period, the world witnessed a revolution based on a digital logic of electrons. From the earliest transistor to the remarkably powerful microprocessor in desktop computers, most electronic devices have employed circuits that express data as binary digits, or bits – ones and zeroes represented by the existence or absence of electric charge. Furthermore, the communication between microelectronic devices occurs by the binary flow of electric charges. The technologies that emerged from this simple logic have created a multi-trillion dollar per year global industry whose products are ubiquitous. The relentless growth of microelectronics is often popularly summarized in Moore's Law, which holds that microprocessors double in power every 18 months as electronic devices shrink and more logic is packed into every chip.

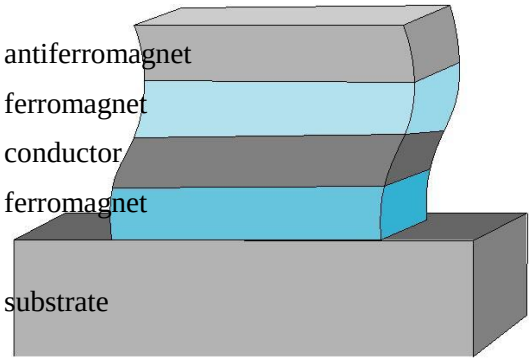
B.Yet even Moore's Law runs out of momentum one day as the size of individual bits approaches the dimension of atoms, which means the end of the silicon road map. To enhance the multi-functionality of devices (e.g. carrying out processing and data storage on the same chip), investigators turned to exploiting another property of the electron – a characteristic known as spin. Spin is a fundamental quantum-mechanical property. It is the intrinsic angular momentum of an elementary particle, such as the electron. The movement of spin, like the flow of charge, can also carry information among devices.

C. One advantage of spin over charge is that spin can be easily manipulated by externally applied magnetic fields. Another more subtle (but potentially significant) property of spin is its long coherence, or relaxation, time – once created it tends to stay that way for a long time, unlike charge states, which are easily destroyed by scattering or collision with defects, impurities or other charges. These characteristics open the possibility of developing devices that could be much smaller, energy efficient and more powerful for some computations compared with electron-charge-based systems.

D. It has been known for decades that in ferromagnetism the spins of electrons are preferentially aligned in one direction. In 1988,

researchers discovered that currents flowing from a ferromagnet into an ordinary metal retain their spin alignment for distances longer than interatomic spaces, so that spin and its associated magnetic moment can be transported just as charge. This means thatmagnetization as well can be transferred from one place to another.

E. The first practical application of this phenomenon is in the giant magnetoresistive effect (GMR). The GMR is observed in thin-film materials composed of alternate ferromagnetic and nonmagnetic layers. The resistance of the material is lowest when the magnetic moments in ferromagnetic layers are aligned in the same direction and highest when they are anti-aligned. This is because the spin-aligned currents from one layer are scattered strongly when they encounter a layer that is magnetically aligned in the opposite direction, creating additional resistance. When the magnetic fields are oriented in the same direction, the spin-aligned currents pass through easily. Current GMR materials operate at room temperature and exhibit significant changes in resistivity when subjected to relatively small external magnetic fields. Thus, they can be used as magnetic field sensors. The imposed magnetic field changes the magnetic orientation of one of the two layers, disrupting their relative orientation and thus changing the resistivity. The first GMR-based magnetic field sensor was created in 1994, and high-performance disk drives utilizing GMR-based read heads to detect magnetic fields were realized in 1997 and now are ubiquitous.



F. Spintronics promises the possibility of integrating memory and logic into a single device. In certain cases, switching times approaching a picosecond are possible, which can greatly increase the efficiency of optical devices such as light-emitting diodes (LEDs) and lasers. The control of spin is central as well to efforts to create entirely new ways of computing, such as quantum computing, or analog computing that uses the phases of signals for computations.

G. Researchers and developers of spintronic devices take two different approaches. In the first, they seek to perfect the existing GMR-based technology either by developing new materials with larger populations of oriented spins (called spin polarization) or by making improvements in existing devices to provide better spin filtering. The second effort, which is more radical, focuses on finding novel ways both to generate and to utilize spin-polarized currents – that is, to actively control spin dynamics.

Comprehension

1. Decide whether in context each of the words in the left-hand column is a noun, verb, adjective or adverb. Match the words with the definitions on the right.

1 coherence	a) never stopping
2 retain	b) completely, or in every way
3 intrinsic	c) present everywhere
4 alternate	d) the position of an object when it is in the correct place in relation to other things
5 ubiquitous	e) relating to the essential qualities or features of something
6 exhibit	f) to become smaller in amount, sire, value or range
7 perfect	g) an occasion when two very different things meet or hit one another

8 encounter	h) the state in which all the different parts fit together
9 shrink	i) to make something completely free from faults or as good as it can be
10 exploit	j) to show a particular quality, ability or form of behavior
11 relentless	k) an amount of a substance that is present in another substance
12 collision	l) to use something so that to benefit from it
13 alignment	m) happening or coming one after another in a regular pattern
14 impurity	n) to keep something
15 entirely	o) to experience or deal with something, especially a problem

2. Ask questions to the following answers.

1. Represent data as binary digits.
2. To enhance the multi-functionality of devices (e.g. carrying out processing and data storage on the same chip).
3. Developing compact, energy efficient and powerful devices.
4. The giant magnetoresistive effect.
5. When subjected to external magnetic fields.

6. To create entirely new ways of computing, such as quantum computing.
7. Finding novel ways to control spin dynamics.

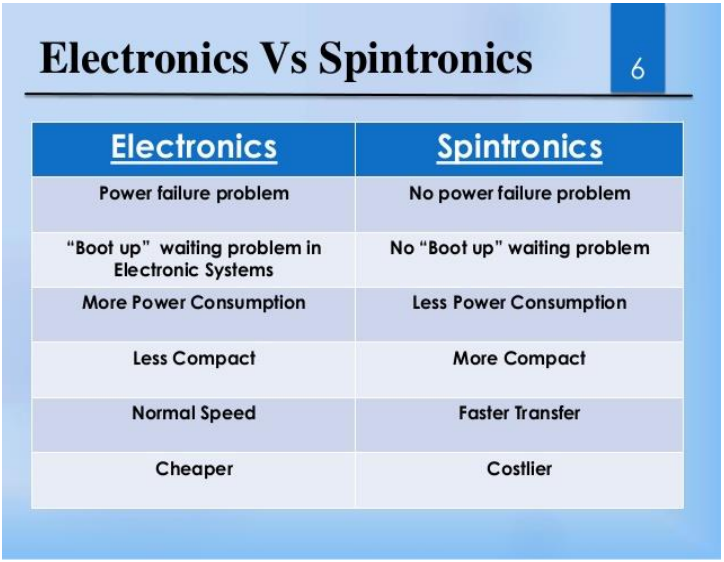
3. Divide the text into logical parts and highlight the topic sentence of each part. Write a summary of the text.

Reading 2

1. The article below is about benefits spintronics provides. Before you read it, work in small groups and brainstorm advantages of spintronics compared to conventional electronics.

2. Work with another group. Compare your ideas and discuss why electron spin could be more effective than charge. Try to give examples of spintronics applications.

3. Read the text to check whether your ideas were right.



Shift from Electronics to Spintronics Opens up New Avenues

Electronics is based on measuring the electrical charge of electrons passing through electronic circuits. An alternative approach, spintronics, uses both the electron charge and spin, a quantum-mechanical property that is intrinsic to electrons to transmit information. Spin can be visualised as the Earth turning on its own axis while rotating around the sun. Similarly, an electron spins on its own axis while rotating around an atom's nucleus. It can roughly be compared to a small magnet that is only able to move in two directions: "spin up" or "spin down." As conventional electronics uses charge to represent information as zeros and ones, the same binary data can be represented using the two spin states in spintronics.

Spintronics has several advantages over conventional electronics. Electronics utilizes specialized semiconductor materials to control the flow of charge through transistors whereas spin can be measured because it generates tiny magnetic fields. Ferrous metals such as iron become magnetic when enough particles have their spin set in the same direction, generating a magnetic field of the same polarity as the spin. Changing spin requires less energy than generating a current to maintain electron charges in a device, so spintronic devices consume less power. Spin states can be set quickly enabling fast data transfer. Since electron spin is not energy-dependent, spin is non-volatile – information sent using spin remains fixed even after loss of power.

The first emblematic effect of spintronics – giant magnetoresistance (GMR) – was demonstrated by Professors Albert Fert and Peter Grünberg awarded the 2007 Nobel Prize in Physics for their discovery. They developed groundbreaking technology by realizing the possibility of using electron spin to increase the rate at which information could be read from a hard disk drive.

A hard disk drive stores data as ones and zeros encoded magnetically on rotating disk platters within the drive. A GMR drive head consists of two ferromagnetic layers, one with a fixed magnetic field direction and the other free to align with the magnetic field encoded on the disk, with a non-magnetic layer sandwiched in between.

When an electron passes through a magnetic field, its spin state changes and becomes scattered thus creating greater resistance to electric current. By aligning electrons' spin state to that of the magnetic field in

the layers of the drive head, GMR technology dramatically reduces resistance, speeding up data transfer. First introduced by IBM in 1997, GMR technology has led to faster and higher-density drives than was previously possible.

Spintronics researchers have since been working on introducing the technology to computer memory, aiming to replace electric current-based dynamic random access memory (DRAM) with magnetic RAM (MRAM). The first commercial product by Everspin has been used inAirbus aircraft and BMW motorbikes due to its reliability under heat stress or cosmic ray exposure – something that affects aircraft cruising at high altitudes.

MRAM exploits the same spin-based magnetic field approach, but uses a magnetoresistance cell to store data rather than a spinning disk platter as in a hard drive. While it is not as fast as DRAM, magnetic cells are able to maintain their stored spin orientations, and the data they represent, without power. MRAM is likely to replace commonly used flash memory such as SD cards and compact flash, as it is faster and does not suffer from flash memory's limited lifespan.

Other manufacturers such as Intel and Samsung are developing MRAM to use as processor cache memory. Their compact MRAM chips of greater capacity enable smaller packages that will be faster, and use up to 80% less power than current cache memory.

As electronics approaches the limits of silicon, spintronic components will play an important role in ensuring steady performance gains, and faster, higher-capacity storage at lower power and cost.

Comprehension

1. Find words in the text that mean the same as the words below.

1) feature
2) inherent
3) revolve
4) traditional
5) necessitate

6) create
7) support
8) innovative, revolutionary
9) level off
10) decrease
11) impact
12) lifetime
13) benefit
14) influence

2. Complete the sentences to summarize the text.

1. In spintronics, the two spin states can be used…
2. The advantages of spintronics over conventional electronics are…
3. GMR technology radically reduces resistance…
4. In computer storage memory, GMR technology enables…
5. MRAM has the advantage of…

Language Focus

1. The goal of spintronics research is to develop a new generation of electronic devices with enhanced performance. Spintronic devices due to their advantages over conventional charge-based electronics tend to spark a revolution in the electronics industry.

Read the text about promising spintronics applications and decide which answer A, B, C, or D best fits each space. There is an example at the beginning (0).

Spin momentum transfer effect predicted theoretically in 1996 and experimentally observed in 2000 was one of the most notable*(0) C*. In SMT, the angular momentum carried by a spin-polarized current can **1**… a torque on the magnetization of a magnetic film that is magnetized in any nonparallel **2**…. This effect, also known as spin torque, ensures

the magnetoresistive random access memory (MRAM) scaling down to 60 nm and below.

Conventional MRAM utilizes current-generated magnetic fields to rotate the magnetization in the free layer. SMT potentially offers orders-of-magnitude lower switching **3**… and much lower energy per bit to write. Apparently, SMT switching can significantly improve the **4**… of MRAM and make it a truly universal memory. SMT-MRAM has the potential to dominate memory technology, particularly **5**… its non-volatility and power efficiency. Even at the 90-nmnode, SMT-MRAM has advantages over flash memory in density, speed, energy, and endurance.

Spin-polarized field-effect transistors. While fast nonvolatile memories could allow increasing computer capabilities, a key bottleneck is moving information between memories and logic **6**…. Ideally, if individual devices could both process and store information, transfer delays could be **7**…, at least for data in immediate use. A spin-based device that could **8**… this dual task is a spin-polarized field-effect transistor (spin FET). In a conventional FET, when a bias voltage is applied, a conducting channel is created between the source and the drain regions, allowing the transistor to act as a **9**…. If source and drain contacts are made from ferromagnetic materials, the electrons **10**… from each contact have a preferential spin. Thus the current can be controlled either by applying a bias voltage as in a conventional FET, or by changing the orientation of the spins as they move from the source to the drain by rotation or by electric-field-controlled scattering.

However, a serious difficulty has so far prevented the development of practical spin FETs. The **11**… of ferromagnetic materials, generally metals, is much higher than that of the semiconductors that make up the rest of the FET. This means that there are far more **12**… electrons in the ferromagnet than in the semiconductors, so only a few of the spin-aligned electrons are able to enter the semiconductor. For a large transfer of spin-aligned electrons, the ferromagnets and semiconductors must have similar conductivity, or there must be a **13**… contact between the ferromagnet and the semiconductor to match the conductivities. One way to achieve this match is to utilize ferromagnetic semiconductors as the source and the drain.

The first ferromagnetic semiconductors with Curie temperatures (TC) above 50 K (−223◦C or −370◦F), developed in 1996, were diluted magnetic semiconductors – alloys in which some atoms are **14**… replaced by magnetic atoms, such as manganese. However, these early materials still had to be cooled to cryogenic temperatures to exhibit ferromagnetism. Subsequent research has shown that other types of semiconductors can exhibit ferromagnetism at much higher temperatures. In 1998 ferromagnetic behavior of GaMnAs was reported with a Curie temperature of about 110 K (−163◦C or −262◦F), which was subsequently raised to nearly 200 K (−73◦C or −100◦F). One of the key features of these materials is that they exhibit carrier-mediated ferromagnetism, in which the ferromagnetism is caused by the **15**… of the magnetic ions with the carriers – electrons or holes. The Curie temperature and other magnetic properties can be modified by changing the carrier concentration with electric fields (gates) or with optical excitation. This ability to gate the magnetism by changing carrier concentration presents a new paradigm for novel devices in which carrier concentration and spin polarization are controlled **16**….

0. **A** theories **B** concepts ***C*** *discoveries* **D** applications

1. **A** exert **B** exhibit **C** energize **D** establish

2. **A** trend **B** vector **C** direction **D** flow

3. **A** voltage **B** amplitude **C** oscillation **D** current

4. **A** performance **B** popularity **C** productivity **D** property

5. **A** in spite of **B** because of **C** as if **D** despite

6. **A** schemes **B** circles **C** paths **D** circuits

7. **A** improved **B** eliminated **C** distributed **D** executed

8. **A** complete **B** control **C** accomplish **D** accelerate

9. **A** switch **B** socket **C** supply **D** storage

10. **A** removed **B** emitted **C** absorbed **D** flown

11. **A** capacity **B** resistivity **C** inductance **D** conductivity

12. **A** stationary **B** rotating **C** mobile **D** escaping

13. **A** tunneling **B** connecting **C** passing **D** coupling

14. **A** simultaneously **B** randomly **C** sequentially **D** gradually

15.**A** influence **B** effect **C** link **D** interaction

16. **A** concurrently **B** separately **C** serially **D** individually

2. Quantum computers, which are the most promising of all spintronics devices, are likely to become a paradigm changing technology in the field of computing.

Work in pairs and discuss the feasibility and purpose of using electron spin in quantum computation. Compare your views with those of other students.

To check your ideas read the text below. While reading, use the words in brackets to form a word that fits in the gap in the sentence.

Another avenue for using the spins of elementary particles comes from the *(0) rapidly(rapid)*developing field of quantum computing. The states of spin of electrons or other spin-1/2 particles can be used as an *1)… (implement)* of a qubit (quantum bit, the unit of quantum information). Information can be encoded using the *2)… (polarize)* of the spin, manipulation (computation) can be done using external magnetic fields or laser pulses, and readout – by measuring spin-dependent transport. Quantum computers execute a series of simple unitary operations (gates) on one or two qubits at a time. The computation on a quantum computer is a sequence of unitary *3)… (transform)* of an initial state of a set of qubits. After the computation is performed, the qubits can be measured, and the outcome of the *4)…(measure)* is the result of the quantum computation. Quantum effects such as *5)… (interfere)* and entanglement are used as *6)… (compute)* resources. For some special problems, such as factorization of large prime numbers or *7)… (exhaust)* database searches, quantum-computing algorithms have been developed that show a very significant speed-up in computation time and a *8)…(reduce)* in *9)… (complex)*. For certain calculations to find global properties of functions such as factoring and discrete logarithms, the speed-up for a quantum processor is dramatic. For these operations, a 30-logical-qubit quantum processor

can perform the same calculation in the same time as a 109-bit classical computer.

Scientists are searching for quantum-mechanical two-state systems with long dephasing times, which would provide the *10)… (able)* to carry out computations before stored information is lost. It must be possible to readily fabricate and scale these quantum systems if they are to perform quantum algorithms. One very viable candidate for quantum information is electron spins in coupled quantum dots. However, other two-level systems have been proposed for implementing qubits, and include nuclear magnetic resonance (NMR), which involves nuclear spins in special molecules and *11)… (excite)* states of ions in traps.

The potential uses of quantum qubit systems range from quantum key*12)(distribute)*, quantum encryption, and quantum dense coding to quantum teleportation and ultraprecise clock synchronization.

3. You are going to read a text about the latest developments in spintronics and promising areas of research. **Seven sentences have been removed from the text. Choose from the sentences (A-H) the one, which fits each gap. There is one extra sentence you need not use.**

Less than ten years elapsed between Albert Fert and Peter Grünberg's demonstration in the laboratory of the emblematic effect of spintronics – giant magnetoresistance – in the late 1980s, and IBM's launch of the first hard drives using this property in 1997. **1**_____.

During the 1960s, theories to describe how spin currents move in magnetic materials were developed. The growth of nanotechnologies in the 1980s and the control over metallic deposits in particular made it possible to create materials with layers whose thickness does not exceed a few nanometers, a pre-requisite for exploiting electron spin.

2_____. Researchers have been trying to push back the frontiers of "conventional" spintronics used in magnetoresistance devices, which consists in placing different materials in the path of electrons in order to influence spin circulation.**3**_____. This is the principle of molecular spintronics aiming at studying such materials as graphene. Spintronics

could enable not only storing information but also transmitting it.**4**_____. This requires understanding how dissimilar materials such as a ferromagnetic metal and molecules share their electronic charge when they form an interface.

New ways of manipulating spins have also emerged in recent years. One of these is spin orbitronics.**5**_____. This domain opens the possibility of storing and transporting information by using skyrmions. These are little spin knots measuring a few nanometers, which can help memorize information. **6**_____. While the production of components based on semiconductors is beginning to reach its limits in terms of miniaturization, spintronics has gradually imposed itself as a complementary technology capable of transcending some of these limits and, in the medium term, probably taking over from conventional electronics.**7**_____. Neuromorphic electronics, for example, draws inspiration from the functioning of the brain, and in particular synapses, which can transform according to the information they receive.

A. Nowadays, spintronics is the subject of fundamental research whose horizons have diversified.

B. To do so, high-performance spin-polarized current sources must be developed.

C. This difference in resistance induced by a magnetic field can be very strong, hence the name giant magnetoresistance.

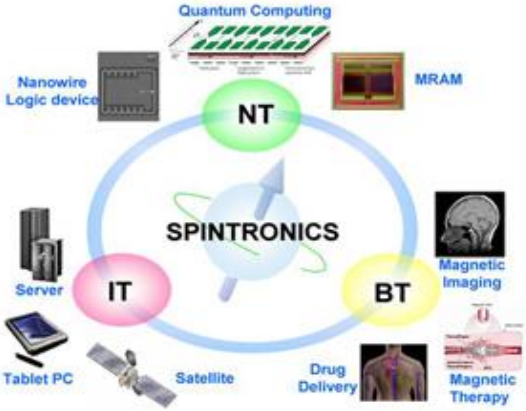
D. Rarely had technology transfer between basic research and mass production been so rapid, an illustration of the spectacular evolution of spintronics over the last twenty years.

E. These skyrmions can then be moved along a track to a nanosensor to read the information coded in a train of skyrmions.

F. Instead of using layers of normal metal, as in the earliest devices, or insulating barriers, as in magnetic tunnel junctions, scientists test other materials, such as assemblages of molecules, in order to filter the electrons according to their spin.

G. In addition to the new components it offers, such as MRAM, spintronics could help define new information architectures – in other words, new ways of computing.

H. The idea is to use a relativistic effect, the spin-orbit coupling, which is quite significant in heavy metals such as bismuth or platinum.



Speaking

1. Work in groups.

Group A: Your research team investigates elementary particles with the view of applying their properties to develop novel devices. You have made a series of successful experiments resulted in creating an innovative device (e.g. sensors, storage or biomedical devices). You will be interviewed for a popular scientific TV program. Prepare a presentation of your device highlighting its functions, features, performance and areas of application.

Group B: You are TV journalists reporting about scientific and technological breakthroughs. Brainstorm questions to interview investigators about their achievements.

Role-play you interviews.

Writing

1. Write an entry for a website of your research institute outlining the concept of spintronics, its perspectives and developments of your research unit in this area.

Reading Strategies

Reading begins with some purpose either general or specific. If your purpose is clear, you should be able to choose a reading strategy and skills to suit your purpose. **Reading skills** include:

- Reading for gist (skimming)
- Reading for specific information (scanning)
- Reading for detail

It is sometimes useful to obtain a general impression of a book, article, or story before deciding whether to read more carefully. *To skim* means to read quickly in order to get a general idea of a passage. Skimming requires you to note only information and clues that provide an idea of the central theme of a piece of writing. When skimming, it is necessary to read only selected sentences, e.g. the first sentences in paragraphs, and use textual clues such as italicized or underlined words, headings or subtitles, spacing, paragraphing, etc.

Once you have a general idea about an article, you may decide to read the entire selection carefully, or only to scan for specific pieces of information to answer questions that have occurred to you.

Scanning is reading quickly to locate specific information in a text. The steps involved in scanning are the following:

1. Begin with a clear understanding of what information you are looking for.
2. Limit your search to one or, at most, two items of information at a time.
3. Decide in advance what form the information may take. For example, if it is a person's name, you will look for initial capital letters. If it is a date, you will look for figures. If it is the description of an event, the discussion of an idea, the definition of a term, or the like, you should be looking for key words, which are likely to occur in such description or discussion.

4. Pass quickly over all material that is not directly related to the information you seek.

Reading for detail involves getting the meaning out of every word and out of the links or relationships between words and between sentences.

1. Would you skim or scan a text to find

1) the most important sections to read?
2) definitions of the key terms?
3) if it would be worth reading the text in detail?
4) what the writer's general view on the topic is?
5) statistics to include in the essay?

2. Skim the text and decide which sentence best summarizes the main idea.

A. Spintronics is an emerging field of electronics, where instead of using the charge of electrons, devices work by manipulating electron spin.

B. Information technology in particular stands to gain the most from spintronics as it can offer considerably higher overall computing speeds and storage capacities at lower power consumption.

C. Recent interest has focused on topological insulators, which are the key to future spintronics technologies. EPFL scientists have unraveled how these materials work, overcoming the obstacles on the way to next-generation applications.

3. Scan the text to find the answers to the following questions.

1. What unusual features do topological insulators have?

2. What technique did researchers use to investigate the conducting surface of a topological insulator?

4. Read the text carefully to answer the questions.

1. Why could information technology benefit from applying the concept of spintronics?

2. What obstacles have researchers encountered attempting to implement topological insulators?

3. What does the ability of the topological insulator to control the electron spin depend on according to the researchers?

4. What opportunities does the research team's discovery provide?

Spintronics: Deciphering a material for future electronics

Future electronics will most likely utilize an intrinsic property of electrons called spin. The state spin takes is either "up" or "down", which in a classical picture corresponds to a clockwise or counterclockwise rotation of the electron around its axis. The electron spin can also be viewed as an extremely small magnetic field surrounding the electron. Already tested in hard drives, spintronicsis believed to replace current information technology, providing increased data transfer speeds, processing power, memory density and storage capacity.

As conventional electronics requires switching between high and low current states, spintronics involves controlling electron spin states and switching between "up" and "down". Controlling electron spin can be achieved with topological insulators, a novel class of materials that behave as insulators on the inside, but are highly conductive on their surfaces. However, it has been unclear so far how exactly a normal material can become a topological insulator, and how to implement them for real technological impact. EPFL scientists offer solutions to both problems by studying the spin structure of few atoms-thick films of a common topological insulator.

An international team of researchers led by Hugo Dil at EPFL has now shown how spin-polarised electrons evolves on the surface of atomically flat bismuth-selenide topological insulator films no more than 30 atoms thick. The researchers used a spectroscopic technique called SARPES, which allowed them to determine the different spin states of electrons travelling across the conducting surface of a topological insulator. They found that the ability of the topological

insulator to control the electron spin depends on its interface to the substrate and not on the film thickness.

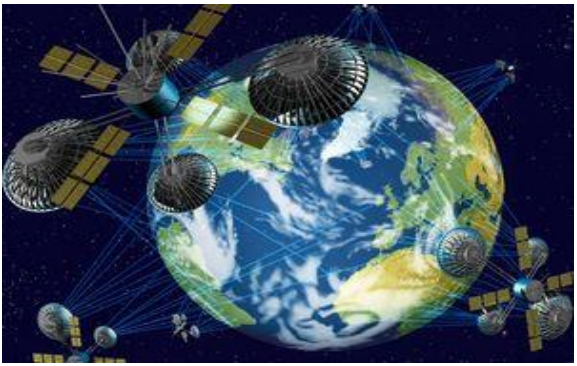
The team's findings show that tuning the chemical make-up of a topological insulator can directly manipulate the spin of electrons flowing across its surface. The discovery not only contributes to the understanding of the function of topological insulators, but also provides a fundamental means of designing spintronics devices in the future.

5. Write a summary of the text.

UNIT 5 Satellite Navigation Systems: GPS

Lead-in

1. "Where am I? How do I get to my destination?" These questions have been asked since ancient times. Various techniques have been tried for centuries to find a solution for the problem of identifying positions.



Work in pairs and brainstorm at least three reasons why people might need to determine their position.

2. Discuss the following questions.

1. In what areas is identifying location of vital importance?
2. What technologies, techniques and instruments are used to determine a position?
3. What techniques do you use to identify your position and find a way? Do you like maps or prefer using a satellite navigation system? Why?

3. Work with another pair. Compare your ideas and agree on the most efficient technology for determining positions. Think of as many arguments as possible to confirm your conclusion.

Vocabulary

1. Satellite navigation systems have revolutionized the area of navigation and proved to be the most efficient and reliable for establishing locations.

These are some basic words used in relation to satellite navigation. Match the terms in the box with the definitions below.

coverage eccentricity constellation inclination
tracking sidereal hour Doppler shift (frequency)
semi-major axis sine wave (carrier frequency)

1. The activity of continuous checking and recording the position and movements of space vehicles and satellites.
2. A parameter that determines the amount by which an astronomical object's orbit around another body deviates from a perfect circle. A value of zero is a circular orbit, values between 0 and 1 form an elliptical orbit.
3. A 24^{th} part of a sidereal day (the time required for a complete rotation of the earth in reference to any star, it is about 4 minutes shorter than a mean solar day).
4. The geographic area where a communications system can operate.
5. One of the six orbital parameters that describes the shape and orientation of a celestial orbit. It is the angular distance of the orbital plane from the plane of reference (for satellite orbits it is usually the equatorial plane, the plane perpendicular to the axis of rotation of the central body), normally measured in degrees.
6. Any periodic oscillation with the waveform of a sine curve, its amplitude, frequency or phase is varied or modulated to transmit a signal.
7. The amount of the change in the frequency of a wave due to the specific effect (it is named after the Austrian scientist who discovered it. It consists in the change in the wavelength (or frequency) of energy in the form of waves, e.g. sound or wave,

resulted from motion either the source or the receiver of the waves), usually expressed in hertz.

8. A number of satellites that are part of a system and have a similar orbit.
9. Either of the equal line segments into which the major axis of an ellipse is divided by the center of symmetry.

2. Form derivatives (nouns, adjectives and adverbs) from the verbs below.

navigate	*operate*	*receive*	transmit
use	*orbit*	*equip*	

Make up sentences using some of the words you have formed.

Reading

1. You are going to read the article about GPS, the global navigation system. Before you read the text, take a guess and choose the correct option to fill in the spaces in the sentences below.

Then compare your answers with those of your partner and decide whose guesses are more accurate.

1. GPS is a U.S. … global navigation system.

   a) ground-based b) sea-based c) space-based

2. The system was developed in the early … .

   a) 1960s b) 1970s c) 1990s

3. GPS comprises … satellites orbiting the Earth.

   a) 24 b) 38 c) 52

4. GPS consists of … segments.

   a) 5 b) 4 c) 3

5. Each GPS satellite transmit a … radio signal.

a) very-high frequency b) microwave c) ultra-high frequency

6. The transmitted signals are controlled by … onboard the satellites.

a) atomic clocks b) computers c) antennas

7. GPS is currently available to … .

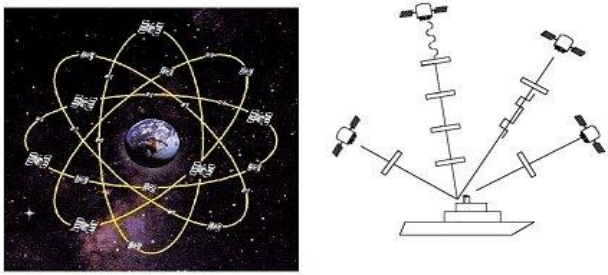
a) military users b) civilian users c) both military and civilian users

2. Read the text and check whether your guesses were right.

GPS: the Components and Basic Concept

1. The Global Positioning System (GPS) is a satellite-based navigation system that was developed by the U.S. Department of Defense in the early 1970s. GPS was designed as a military system to fulfill U.S. military needs. However, later it become available to civilians, and now it is a dual-use system that can be accessed by both military and civilian users.

2. GPS provides continuous positioning and timing information, anywhere in the world under any weather conditions. Since the system not only serves an unlimited number of users but also is used for security reasons, GPS is a one-way-ranging (passive) system, i.e. users can only receive the satellite signals.



GPS Navigation

3. GPS consists of a constellation of 24 operational satellites. This constellation, known as the initial operational capability (IOC), was completed in July 1993. To ensure continuous worldwide coverage, GPS satellites are arranged so that four satellites are placed in each of six orbital planes. This constellation geometry allows making four to ten GPS satellites visible anywhere in the world at an elevation angle of 10°.

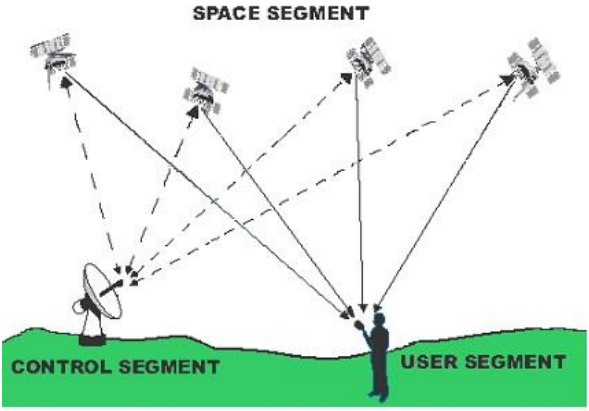
4. GPS satellite orbits are nearly circular (an elliptical shape with a maximum eccentricity is about 0.01), with an inclination of about 55° to the equator. The semi-major axis of a GPS orbit is about 26,560 km (i.e., the satellite altitude of about 20,200 km above the Earth's surface). The corresponding GPS orbital period is about 12 sidereal hours (~11 hours, 58 minutes). The GPS system was officially declared to have achieved full operational capability (FOC) on July 17, 1995, ensuring the availability of at least 24 operational GPS satellites. In fact, the number of satellites in the GPS constellation has always been more than 24 operational satellites.

5. GPS consists of three segments: the space segment, the control segment, and the user segment. The space segment includes the 24-satellite constellation. Each GPS satellite transmits a microwave radio signal composed of two sine waves (also known as carrier frequencies) modulated by two digital codes and a navigation message. The two carrier frequencies are generated at 1,575.42 MHz (referred to as the L1 carrier) and 1,227.60 MHz (referred to as the L2 carrier). The corresponding carrier wavelengths are approximately 19 cm and 24.4 cm, respectively, which result from the relation between the carrier frequency and the speed of light in space. The availability of the two carrier frequencies allows for correcting a major GPS error, known as the ionosphere delay. All of the GPS satellites transmit the same L1 and L2 carrier frequencies. The code modulation, however, is different for each satellite, which significantly minimizes the signal interference.

The codes and the navigation message are added to the carriers as binary bi-phase modulations. The carrier and the codes are used to determine the distance from the user’s receiver to the GPS satellites. The navigation message contains, along with other information, the coordinates (the location) of the satellites as a function of time. The

transmitted signals are controlled by highly accurate atomic clocks onboard the satellites.

The control segment of the GPS system consists of a worldwide network of tracking stations, with a master control station (MCS) located in the United States at Colorado Springs, Colorado. The primary task of the operational control segment is tracking the GPS satellites to determine and predict satellite locations, system integrity, the satellite atomic clock operation and atmospheric data, the satellite almanac (rough orbits and status information for each satellite in the constellation). This information is then packed and uploaded into the GPS satellites through the S-band link.



The user segment includes all military and civilian users.

6. The idea behind GPS is rather simple. A GPS receiver picks up the GPS signal through the antenna and processes it using its built-in software. The outcome of the signal processing is the distances to the GPS satellites in the form of digital codes (known as the pseudo-ranges) and the satellites coordinates through the navigation message.

7. One of the important GPS uses is determining the user's velocity by several methods. The most widely used method is based on estimating the Doppler frequency of the received GPS signal. It is known that the Doppler shift occurs due to the relative satellite-receiver motion. GPS may also be used in determining the attitude of a body, such as an aircraft or a marine vessel. The word "attitude" means the orientation, or the direction, of the body, which can be described by the three rotation angles of the three axes of the body with respect to a reference

system. Attitude is determined by equipping the body with a minimum of three GPS receivers (or one special receiver) connected to three antennas, which are arranged in a non-straight line. Data collected at the receivers are then processed to obtain the attitude of the body.

Comprehension

1. Find words in the text with the following meaning.

1. To have the right or opportunity to get or use something (e.g. information)
2. Happening without stopping or being interrupted
3. To provide something that people need
4. Able to be seen
5. The height of an area of land, usually measured from sea level
6. To send data or programs from one computer to a larger system
7. A mistake, e.g. in a calculation or a decision
8. The quality of being in a good condition, without any damage or mistakes
9. The ability to do something in a precise way

2. The text contains a number of important collocations (fixed expressions). Match words in A with words in B to make collocations and use them to complete the sentences given below.

A	B
worldwide	code
navigation	wavelength
weather	software
digital	coverage
atomic	interference

reference	conditions
built-in	station
carrier	clock
tracking	system
signal	message

1. The … result from the relation between the carrier frequency and the speed of light in space.
2. The … contains, along with other information, the coordinates of the satellites as a function of time.
3. The receiver processes the GPS signal using its ….
4. GPS provides positioning and timing information worldwide under any ….
5. The transmitted signals are controlled by highly accurate … onboard the satellites.
6. Attitude of the body can be described by the three rotation angles of the three axes of the body with respect to ….
7. To provide continuous …, GPS satellites are arranged so that four satellites are placed in each of six orbital planes.
8. One of the outcomes of the signal processing includes the distances to the GPS satellites through ….
9. The control segment of the GPS system consists of a worldwide network of….
10. The code modulation is different for each satellite to minimize ….

3. Ask questions to which the following statements could be answers.

1) To fulfill U.S. military needs.
2) Because GPS serves an unlimited number of users.

3) Four to ten GPS satellites.

4) Two sine waves, two digital codes, and a navigation message.

5) The availability of the two carrier frequencies.

6) To all users worldwide.

7) Because of the relative satellite-receiver motion.

8) By equipping the body with three GPS receivers

4. The text can be divided into several logical parts. How many parts can be distinguished? What is the topic of each part? Think of a title for each part and write an outline of the text.

Compare your outline with this of your partner. Do you have the same or different number of parts?

Language Focus

1. Work in pairs and discuss what experimental satellite navigation systems led to the development of the modern positioning systems.

To find out more about the history of GPS and check your ideas read the passage below. The sentences in the passage have been jumbled. Rearrange the sentences to make up a complete text.

History of GPS

1. The design of GPS is based partly on similar ground-based radio navigation systems, such as LORAN and the Decca Navigator developed in the early 1940s, and used during the Second World War.

2. The first GPS satellite was launched in 1989 and the 24th was put into orbit in 1994.

3. A team of U.S. scientists led by Dr. Richard B. Kushner was monitoring Sputnik's radio transmissions.

4. In 1967, the U.S. Navy developed the Timation satellite, which proved the feasibility of placing accurate clocks in space, a technology that GPS relies upon.

5. The launch of the first artificial satellite, Sputnik, by the Soviet Union in 1957 inspired another stage in the GPS development.

6. The first satellite navigation system, Transit, used by the United States Navy was successfully tested in 1960.

7. Initially, the highest quality signal was reserved for military use, and the signal available for civilian use intentionally degraded (Selective Availability).

8. In the 1970s, the ground-based Omega Navigation System operating on phase comparison of signal transmission from pairs of stations became the first worldwide radio navigation system.

9. They discovered that, because of the effect, the frequency of the signal being transmitted by Sputnik became higher as the satellite approached and lower as it continued away from them.

10. It used a constellation of five satellites and could provide a navigational fix approximately once per hour.

11. In 1983, President Ronald Reagan issued a directive making GPS freely available for civilian use as soon as it was sufficiently developed.

12. Selective Availability was cancelled in 2000, thus, the precision of civilian GPS was improved from 100 meters to about 20 meters.

13. They realized that since they knew their exact location on the globe, they could pinpoint the satellite position along its orbit by measuring the Doppler distortion.

2. Positioning, or finding the user's location, with GPS requires some understanding of the GPS signal structure and how the measurements can be made.

Read the text about the signal structure and fill in the gaps with appropriate words. You should use auxiliary verbs, articles, prepositions, conjunctions and pronouns. There is an example (0) at the beginning.

GPS Signal Structure

The two GPS codes *(0) are* called coarse acquisition (or C/A-code) and precision (or P-code). Each code consists 1)… a stream of binary digits known 2)… bits or chips. The codes are generated using a mathematical algorithm. The C/A-code is modulated onto the L1 carrier only, 3)… the P-code is modulated onto both the L1 and the L2 carriers. This modulation is called bi-phase modulation, 4)… the carrier phase is shifted by 180° when the code value changes from zero to one or from one to zero.

The C/A-code is a stream of 1,023 binary digits that repeats 5)… every millisecond. This means that the chipping rate of the C/A-code is 1.023 Mbps. 6)…, the duration of one bit is approximately one millisecond that is equivalent to 300m. Each satellite is assigned a unique C/A-code that enables the GPS receivers to identify 7)… satellite is transmitting a particular code. 8)… C/A-code range measurement is less precise compared 9)… that of the P-code. It is, however, less complex and is available to all users.

The P-code is a very long sequence of binary digits that repeats itself after 266 days. It is also ten times faster 10)… the C/A-code (i.e., its rate is 10.23 Mbps). The 266-day-long code 11)… divided into 38 segments, each is one week long. Thirty twoof these segments are assigned to the various GPS satellites. That is, each satellite transmits 12)… unique 1-week segment of the P-code, which is initialized every Saturday/Sunday midnight crossing. The remaining six segments are reserved for 13)… uses. A GPS satellite is usually identified by 14)… unique 1-week segment of the P-code. The P-code is designed primarily 15)… military purposes.

The GPS navigation message is a data stream added to both the L1 and the L2 carriers as binary bi-phase modulation 16)… a low rate of 50 kbps. It includes 25 frames of 1,500 bits each, or 37,500 bits in total. This means that the transmission of the complete navigation message takes 750 seconds, or 12.5 minutes. The navigation message contains the coordinates of the GPS satellites as a function of time, the satellite health status, the satellite clock correction, the satellite almanac, and atmospheric data. Each satellite transmits its own navigation message

with information on the other satellites, 17)… the approximate location and health status.

3. The GPS signal is picked up by a GPS receiver. Therefore, understanding the features and limitations of various types of GPS receivers is essential.

The passage below is about the GPS receiver types. Skim it quickly without paying attention to the gaps in order to find out

- what types of GPS receivers are available
- what features should be taken into account while choosing a GPS receiver.

4. Read the text and decide which word A, B, C or D best fits each space. There is an example (0) at the beginning.

Types of GPS Receivers

In 1980, only one commercial GPS receiver was available on the market at a price of several hundred thousand U.S. dollars. The situation, however, has changed *(0)* *considerably* since more than 500 different GPS receivers are available in the market today. A GPS receiver requires an antenna 1)… to it, either internally or externally. The antenna receives the incoming satellite signal and 2)… its energy into an electric current, which can be handled by the GPS receiver.

Commercial GPS receivers can be divided into four types, according to their receiving 3)…. These are single-frequency code receivers, single-frequency carrier-smoothed code receivers, single-frequency code and carrier receivers, and dual-frequency receivers. Single-frequency receivers access the L1 frequency only, while dual-frequency receivers access both the L1 and the L2 frequencies. GPS receivers can also be categorized according to their number of tracking 4)…, which varies from one to 12. A good GPS receiver would be multichannel, with each channel 5)… to continuously tracking a particular satellite. Most GPS receivers have from nine to 12 independent (or parallel) channels. Features such as cost, ease of use, power 6)…, size and weight, internal and/or external data-storage capabilities, interfacing capabilities, and multipath mitigation are to be considered when choosing a GPS receiver.

The first receiver type, the single-frequency code receiver, measures the pseudo-ranges with the C/A-code only. No other measurements are available. It is the least expensive and the least 7)… receiver type, and is mostly used for recreation purposes. The second receiver type, the single-frequency carrier-smoothed code receiver, also measures the pseudo-ranges with the C/A-code only. However, with this receiver type, the higher-resolution carrier frequency is used internally to 8)… the resolution of the code pseudo-range, which 9)… in high-precision pseudo-range measurements. Single-frequency code and carrier receivers output the raw C/A-code pseudo-ranges, the L1carrier-phase measurements, and the navigation message. In 10)…, this receiver type is capable of performing the functions of the other receiver types.

Dual-frequency receivers are the most 11)… and expensive receiver type that outputs the key GPS signal components.

0. **A** importantly **B** consistently ***C considerably*** **D** very

1. **A** attached **B** attendant **C** adjacent **D** adjoined

2. **A** circulates **B** combines **C** converts **D** collects

3. **A** opportunities **B** chances **C** capabilities **D** functions

4. **A** paths **B** channels **C** ways **D** routes

5. **A** destined **B** derived **C** deserved **D** dedicated

6. **A** use **B** consumption **C** dissipation **D** application

7. **A** popular **B** accurate **C** available **D** widespread

8. **A** improve **B** modify **C** upgrade **D** change

9. **A** leads **B** indicates **C** results **D** presents

10. **A** fact **B** conclusion **C** general **D** addition

11. **A** sophisticated **B** fashionable **C** eye-catching **D** amazing

5. Read the extract about measuring the range to the satellites and choose the correct form in each case.

Pseudo-range Measurements

The pseudo-range is a measure of the range, or distance, between the GPS receiver and the GPS satellite (more precisely, it is the distance between the GPS receiver's antenna and the GPS satellite's antenna). The ranges from the receiver to the satellites are *1) required/requires* for the position computation. Either the P-code or the C/A-code can be used for *2) measuring/measured* the pseudo-range.

The procedure of the GPS range determination can be described as follows. Let us assume that both the satellite and the receiver clocks, which control the signal generation, are perfectly *3) synchronizing/synchronized* with each other. When the code is transmitted from the satellite, the receiver *4) is generated/ generates* an exact replica of that code. The transmitted code will *5) be picked up/pick up* by the receiver in a moment equal to the signal travel time in space. Comparing the *6) transmitted/having transmitted* code and its replica, the receiver can compute the signal travel time. Multiplying the travel time *7) to/by* the speed of light *8) gives/is given* the range between the satellite and the receiver.

Unfortunately, the assumption that the receiver and satellite clocks are synchronized *9) are/is* not exactly true. In fact, the measured range is deteriorated, along *10) in/with* other errors and biases, by the *11) synchronize/synchronization* error between the satellite and receiver clocks. For this reason, this quantity is referred *12) on/to* as the pseudo-range, not the range.

GPS was designed so that the range *13) determining/determined* by the civilian C/A-code would be less precise than that of military P-code. This is based *14) on/in* the fact that the resolution of the C/A-code, 300m, is ten times lower than the P-code. Surprisingly, *15) because/due to* the improvements in the receiver technology, the obtained accuracy was almost the same from both codes.

6. Although GPS was originally designed as a military system, its civil applications have grown much faster. Nowadays GPS has numerous land, marine and airborne applications.

Work in groups and brainstorm what benefits people derive from using GPS. Make a list of the most important GPS applications.

Compare your views with those of other students and decide on the most vital and perspective GPS uses.

7. Read the text about GPS applications and check whether your ideas were right. Ten sentences have been removed from the text.

While reading, choose from the sentences (A- K) the one, which fits each gap. There is one extra sentence you need not use.

GPS Applications

GPS has found its way into many industrial applications, replacing conventional methods in most cases, because it provides high-accuracy positioning in a cost-effective manner. The GPS technology is indispensable for mapping, surveying, monitoring different structures and activities, automatic machine guidance and control. Vehicle tracking and navigation are among the most rapidly growing applications.

Accurate and up-to-date maps of utilities are essential for utility companies.**1**_____. The GPS system provides a cost-effective, efficient and accurate tool for creating utility maps. With the help of GPS, locations of gas lines can be accurately collected, along with their conditions. Buried utilities such as electric cables or water pipes can also be mapped efficiently using GPS.

GPS has been applied successfully in many areas of the forest industry. Typical applications include fire prevention and control, harvesting operations, insect infestation, boundary determination and aerial spraying. **2**_____. GPS is a key technology that enables a system operator to identify and monitor the exact location of the resources.

Civil engineering works are often done in a complex and dangerous environment, making it difficult for personnel to operate efficiently. **3**_____. Construction firms use GPS in many applications such as road construction and fleet management.

Since its early development, GPS has been used for monitoring the stability of structures, an application that requires the highest possible accuracy. The system is used for monitoring the deformation of dams, bridges, TV towers and ground subsidence of oil fields and mining areas. **4**_____.

Slow-deforming structures such as dams require sub-millimeter- to millimeter-level accuracy to monitor their displacement. Although this accuracy level may be achieved with GPS alone under certain conditions, it is not a cost-effective method. To monitor such structures effectively, GPS should be supplemented with geotechnical sensors and special types

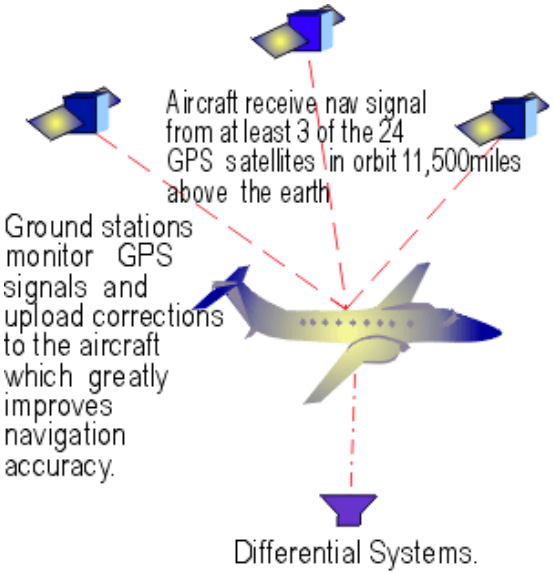
of stations. Bridges, in contrast, are subjected to vibrations caused by dynamic traffic loads. **5**_____.

GPS is successfully used for topographic mapping of small-size areas. A user takes positions of the points on the ground where the topography changes for producing the topographic map of that area. However, the use of GPS alone becomes time-consuming and cost-ineffective for mapping large areas, coastal areas, forests and inaccessible areas.

Traditionally, classical airborne photogrammetry was applied for this purpose. **6**_____. For practical use, the captured images must first be related to the geodetic reference system, a process known as geo-referencing the images. In classical airborne photogrammetry, the geo-referencing is done indirectly with the help of a number of ground control stations with known geodetic coordinates and their corresponding image coordinates. **7**_____. The use of GPS in airborne photogrammetry has significantly reduced the required number of ground control points. Direct geo-referencing of the captured images can be achieved when using an integrated GPS/ inertial system onboard the aircraft that allows the captured images to be directly related to the geodetic reference system without using ground control points.

8_____. LIDAR uses an airborne laser scanner to measure the altitude of the points above the ground level. Combining the GPS/inertial-based position and orientation of the laser with the measured altitude of the points leads to direct acquisition of accurate digital elevation models (DEM). Another advantage of the LIDAR system is that the data can be collected at night as well as under cloudy and high wind conditions. Moreover, the LIDAR system can be used in mapping featureless areas such as deserts and areas covered by snow and ice and is attractive to the forest industry as well.

The technology incorporating GPS with digital road maps and a computer allows obtaining route guidance electronically with a touch of a button. The vehicle location is superimposed on an electronic digital road map, containing in its database digital information such as street names and directions, airports, attractions, and other related information. **9**_____. Factors such as shortest distance and time to destination, one-way roads, illegal turns, and rush-hour restrictions, are all considered in



the path finding. The driver usually gets turn-by-turn instructions, with audio and/or visual indications, to the destination. If the driver misses a turn, the system displays a warning message and finds an alternative best route based on the current location of the vehicle. Some manufacturers add wireless systems to provide weather and traffic information and to locate the vehicles in case of emergency as well as the Internet access from their vehicles.

GPS has become the most valuable method of navigation in the modern aviation world due to its accuracy, reliability and ease of use. The GPS system applies triangulation technique to determine the exact aircraft position and provide pilots with precise location data. **10**_____.

Some high-end GPS receivers even provide turn-by-turn navigation assistance when taxiing an aircraft on the ground.

A. The GPS ability to provide real-time sub-meter- and centimeter-level accuracy in a cost-effective way has significantly changed the civil engineering industry.

B. Integrated GPS/GLONASS and GPS/digital barometer systems have been used in situations of poor GPS signal reception.

C. To monitor effectively such cyclic deforming structures dual GPS receivers should be located at several points with maximum amplitude of cyclic deformation.

D. The availability of such maps helps electric, gas and water utility companies to plan, build and maintain their assets.

E. Other applications such as airborne remote sensing and light detection and ranging (LIDAR) benefit greatly from direct geo-referencing using the integrated GPS/inertial system.

F. Deformation monitoring is done by taking GPS measurements over the same area at different time intervals.

G. Modern GPS receivers supply real-time air traffic information, weather reports, coloured terrain mapping and airport directory information.

H. Since the forest service encounters thousands of fires every year, an efficient resource-management system is essential.

I. In recent years, GPS has been used onboard the aircraft to provide the precise position of the aerial camera and the precise time of each aerial exposure.

J. Once the driver inputs a destination the built-in computer finds the best route to reach that destination.

K. With this method, an aircraft-mounted camera captures a sequence of images for the area to be mapped.

Speaking

1. Suppose that the research laboratory you work for specializes in developing innovative communications systems. Your team is responsible for a concept of an advanced GPS receiver. Hold a meeting with your partners to decide on

- performance and technical characteristics of a receiver
- its purpose and functions it will provide
- operational principles
- optional features, upgrading
- areas of application
- budget you would need to develop and test a receiver
- how you are going to promote a receiver

2. Take turns to make a presentation of your concept to the group. Which project is the best?

3. Work in two groups.

Group A. You are designers of a new enhanced GPS receiver.

You have been invited to participate in an international exhibition and present your device. Be prepared to demonstrate your device and answer visitors' questions.

Group B. You are visitors to an international exhibition.

You are interested in innovative satellite systems. Brainstorm questions you could ask about a new GPS receiver you see at the exhibition. You would like to find out about its performance, functions, features, advantages and price.

Role-play your conversation.

Writing

1. You have been asked to write a review of GPS receivers currently in the market for a popular website on electronic gadgets.

In your review, you should describe models available in the market at present, express your opinion of them highlighting their advantages and drawbacks and make recommendations which one to choose.

2. Write a plan for your review including:

- Introduction: available models, your opinion of them
- Main body: description of gadgets, analysis of their advantages/drawbacks
- Conclusion: a recommendation

3. Write your review. Write 180-200 words.

Grammar: The Infinitive

The infinitive is a non-finite verb form that combines properties of the verb and noun. Being a verbal form, the infinitive names an action (to

make an experiment) or state (to be sick), but does not show person, number, or mood. The infinitive has active and passive forms (to take; to be taken), can be followed by a direct object (He plans to visit an exhibition) and modified by an adverb (He tried to walk quickly).

The infinitive does not show tense. The time reference is shown by the context or by the tense of the verb in the main clause.

The action indicated by the infinitive can be simultaneous with the action expressed by the verb.

Their proposal was the first one *to be debated* at yesterday's planning meeting (past). He is trying *to solve* a problem (present).

We use **the perfect infinitive** for an event that happened before the main clause.

It is nice *to have talked* to you. *Not to have acted* sooner is his greatest regret.

Forms of the infinitive

	Active	Passive
Simple	to mend	to be mended
Continuous	to be mending	to be being mended (is not common)
Perfect	to have mended	to have been mended
Perfect continuous	to have been mending	----------

I asked him *to write* a report. He is supposed *to be writing* a report now. He appears *to have written* a report already. He seems *to have been writing* a report for two hours already. I expect his report *to be written* tomorrow. I expect his report *to have been written* by now.

The infinitive also possesses some properties of the noun, which determine its syntactical functions in sentences. The infinitive can

function as the subject, part of the compound predicate, an object, an attribute, an adverbial modifier.

Functions of the infinitive

The subject	*To link* theory with practice is of great importance. (Связь теории с практикой чрезвычайно важна.) It was quite necessary *to implement* the project.(Было необходимо осуществить проект.)
Part of the compound predicate 1) the predicative 2) part of the compound verbal predicate (with modal verbs and the verbs to begin, to continue, to finish)	1) His duty is *to register* the results of experiments. (Его обязанность (заключается в том, чтобы) регистрировать результаты экспериментов.) 2) They had *to improve* the device to obtain more accurate data. (Они были вынуждены усовершенствовать прибор, чтобы получить более точные данные.) He began *to conduct* the experiment last week. (Он начал проводить эксперимент на прошлой неделе.)
The object	He tried *to use* this device in his research. (Он попытался использовать устройство в своем исследовании.)
The attribute	Attempts *to develop* the machine were made last century. (Попытки разработать этот механизм предпринимались в прошлом веке.) It is not the right time *to discuss* the question. (Сейчас не совсем подходящее время обсуждать этот вопрос.)

	The project *to realize* was rather complicated. (Проект, который необходимо было осуществить, был достаточно сложным.) He was the first *to apply* this approach to research. (Он первым применил этот метод исследования.)
The adverbial modifier 1) of purpose 2) of result	1) *To study* the properties of the substance they made a series of experiments. (Для того чтобы изучить свойства вещества, они провели ряд экспериментов.) 2) The method is not accurate enough *to give* reliable results. (Метод недостаточно точен, чтобы дать надежные результаты.)

Certain verbs can be followed by an infinitive functioning as **an object**.

Verb+ infinitive afford, agree, aim, appear, ask, attempt, beg, choose, decide, demand, deserve, expect, fail, forget, hate, hesitate, hope, intend, learn, like, love, manage, mean, need, offer, plan, prefer, prepare, pretend, promise, refuse, regret, remember, seem, tend, threaten, trouble, try, wait, want, wish

He *refused to help* them. She has *decided to apply* for the job.

The verbs *allow, permit, ask, tell, order, force, advise, warn, encourage* can be used in the passive voice with the infinitive in the function of an object after them.

She allowed us to go there. – We *were allowed to go* there.

They warned me not to do it. – I *was warned not to do* it.

He advised her to find a good lawyer. – She *was advised to find* a good lawyer.

Many adjectives, especially those describing feelings, can be followed by to+ infinitive: able, afraid, amused, anxious, ashamed, astonished, careful, delighted, determined, disappointed, eager, free, frightened,

glad, grateful, happy, interested, lucky, pleased, prepared, proud, ready, relieved, reluctant, sad, shocked, sorry, surprised, terrified, willing.

We are *ready to start*. She was *reluctant to go* there alone.

The infinitive as **an attribute** follows the noun (or indefinite pronoun) that it modifies.

Can you give me *a book to read*? I have a lot of *work to do* today.

Infinitives as attributes are used after many nouns: ability, advice, attempt, capacity, chance, command, decision, desire, eagerness, effort, excuse, failure, intention, invitation, necessity, need, offer, opportunity, order, permission, power, promise, reason, recommendation, refusal, reluctance, right, time, way, willingness, wish.

Her *ability to memorize* words is amazing. I have no *intention to work* there.

The infinitive functioning as **the subject** often precedes the predicate.

To know the rules is necessary. *To ask* him for help was a mistake.

However, it is more common to use the pronoun *it* as the formal subject and put the infinitive after the predicative adjective or noun.

It is *necessary to know* the rules. It was *a mistake to ask* him for help.

The predicative adjectives and nouns are the following: advisable, amazing, awful, bad, convenient, careless, correct, cruel, dangerous, desirable, difficult, easy, foolish, funny, good, great, hard, helpful, important, impossible, interesting, intolerable, natural, necessary, nice, pleasant, possible, reasonable, ridiculous, silly, strange, surprising, terrible, unbearable, undesirable, unnecessary, unpleasant, unreasonable, useful, useless, wise, wonderful, wrong; duty, fun, idea, mistake, pleasure, surprise, thing, time.

It is *useless to talk* to him. It was *dangerous to stay* there.

It is *time to leave*. It was a terrible *thing to say*.

1. Complete the sentences with the correct infinitive form of the verbs in brackets. There is an example at the beginning (0).

0. I am sorry (disturb) you, but the matter is urgent.

I am sorry **to disturb** you, but the matter is urgent.

1. We pretended not (notice) the mistake he had made not (embarrass) him.
2. She does not like (disturb) during her work.
3. We are happy (travel) in Europe for a month.
4. She is smiling all the time. She must (read) something funny.
5. After the first successful demonstration of his wireless A. S. Popov started (perfect) it.
6. Our task is (develop) technological processes without a direct participation of man.
7. She is lucky (give) such an opportunity.
8. The material (use) has been carefully examined.
9. (Tell) the truth, I do not think this is the kind of question (discuss) in public.
10. He read a lot (broaden) his mind.
11. The goods are (deliver) next week.
12. He appears (forget) about the meeting.
13. I am delighted (discuss) this important question with you now.
14. It takes a long time (become) a personality.
15. He has a talent (make) the best of any bad situation.
16. One line can be used (send) many messages at the same time if each message is sent out at a different frequency.
17. (Solve) the problem they decided (make use) of the helium-neon laser.

18. (Tell) the truth, I work alone, I have no partner (worry) about.
19. Having small size and other useful properties transistors make it possible (produce) devices which cannot (make) with vacuum tubes.
20. Many infrared detectors must (cool) to low temperatures (show) useful sensitivity.

2. Insert *to* before the infinitive where necessary.

1. We did everything we could… make him… join us.
2. You cannot… make me… do what I do not want….
3. You ought… have told me all this before.
4. Will you be able… let your son… decide his future?
5. "First of all I'd like… introduce myself", said the lecturer.
6. If you fail, why not…take a chance again, you may… be luckier next time… become a winner.
7. Let me… help you… solve the problem.
8. I wonder what made him… take such a decision.
9. Are you sure you can… afford… waste another year?
10. He was seen… enter the house through the back door.
11. I'd rather… come early than… be late.
12. We stepped aside… let them… pass.
13. What made you… decide… enter that competition?
14. Several requirements are… be met… make such a device… operate efficiently.
15. Do not let that… bother you.
16. Julie made the insurance company… pay for the repairs.

3. In the sentences below, define the form and function of an infinitive.

1. Nowadays it is hardly possible to solve complex engineering problems without the help of computers.
2. Valves at the transmitting station are used to keep the electric circuits oscillating.
3. To communicate information of some sort must be transferred.
4. Electronic technology has made it possible to establish automatic communication systems.
5. The report is to be handed in first thing tomorrow morning.
6. I do not know this subject well enough to discuss it with you.
7. The most convenient way to change alternating to direct current is by means of a rectifier.
8. To read books means to enlarge one's horizons.
9. They were glad to have been invited to participate in this famous scientist's research.
10. To meet the requirements the circuit must be assembled using cutting-edge technology.
11. To have been recognized as a talented designer gave him great satisfaction.
12. Internet gives everyone the power to share information and ideas, the power to move business forward.
13. The objective is not only to identify the problem, but also to solve it.
14. The circuit can be broken to interrupt the flow of electricity.
15. Solar and atomic batteries are used to supply power to transmitters in spacecraft because of their long life.
16. The excessive heat during the operation of the device was one of the problems to be solved.
17. To carry out the task they had to work for three hours.

18. Experience had shown that the best way to send a weak radio signal from and through space is to use a signaling method known as pulse-code modulation.
19. At low frequencies, the carrier wave has too slow a rise to be of any use.
20. To strengthen the magnetic field means to increase the acceleration of particles.
21. Man's mind interprets vital data too slowly to keep track of many modern weapons and vehicles. The electronics steps in to react, to interpret, to compute, to control, and finally to take the place of man's senses and mind.
22. In order to express the magnitude of a force some standard force must be selected as a unit in terms of which other forces must be expressed.
23. To predict the existence of an unknown phenomenon or object has always been considered a topmost achievement for the theory.
24. The Rolex Company was the first to develop the idea of a modern watch.
25. The classical laws of mechanics and electricity fail to predict the behavior of atoms.
26. The aim of the machine designer is to predict accurately the performance of a machine he intends to build. To do so he must know the theory of operation and must be able numerically to evaluate the theory.
27. To be effective such controls must extend through all processes of manufacture from the raw material to the final deposition of the component in the finished equipment.
28. Engineers have tested the machine to be put into operation tomorrow.
29. It is impossible to develop the economy without searching for new sources of energy.

30. It was found that the forward resistance of diodes is too variable to use the diode in place of a relay.
31. The term “integrated circuit” is used to describe a group of electronic elements connected to get her by a variety of circuit assembly techniques to perform a given electronic function.
32. As the voltage applied between the electrodes in an ionization chamber is comparatively low, each quantum of X-rays absorbed produces only a small burst of current, too small to be recorded individually by any conventional method.

4. Replace the subordinate clause with an infinitive. Define the function of an infinitive. There is an example at the beginning (0).

0. The problem, which will be discussed, is very important. The problem to be discussed is very important (an attribute).

The negative poles in this case are so far away that they do not influence the positive poles. The negative poles in this case are far enough away so as not to influence the positive poles (an adverbial modifier of result).

1. This is an interesting fact, which you can mention in your speech.
2. There is no one who could explain it better than you.
3. You are so experienced –you ought to know better.
4. If you intend to do the work well, you must be very careful.
5. The thickness of the product, which should be measured, determines the choice of radioisotope, which will be used as the source.
6. There was nothing that could attract our attention.
7. If one needs to determine the magnitude of anything, it necessitates making a measurement.
8. The penetrating power of the new radiation was an obvious phenomenon that scientists had to investigate.
9. The detectives needed special equipment because they had to investigate the mystery thoroughly and accurately.

10. All the attempts that were aimed to explain the processes of emission and absorption through the electromagnetic theory of light have failed.

5. Make the sentences passive.

0. They saw him **do** it. – He was seen **to do** it.

1. They made the customer accept their terms.
2. They consider him to be an expert in his sphere.
3. She regards her father a perfect example to follow.
4. Everybody knows that this theatre was built by a famous architect.
5. We expect that they have learnt the truth.
6. It was announced that the foreign delegation had arrived.
7. It is understood that the partners have come to an agreement.
8. It was reported that the verdict was announced.
9. Everyone heard her say that.
10. We heard the postal worker come up to the front door and then we saw him slip a thick envelope into the box.
11. The teacher made me write the test again.
12. They saw the device begin to operate.

UNIT 6 Satellite Navigation Systems: GPS or GLONASS?

Lead-in

1. It is undeniable that GPS has become indispensable worldwide. It plays a crucial role in an enormous range of activities. Nevertheless, is GPS exceptional, the only system available for navigation nowadays?

Work in pairs and discuss the following questions.

1. What other satellite navigation systems have been developed in the world?

2. What countries are planning to develop satellite-based navigation systems?

2. Try to guess what acronyms GNSS, GLONASS, DORIS stand for.

Compare your ideas with those of other students. Whose guesses are the most accurate?

3. To check whether your guesses were correct read the extract below. While reading complete it by filling in the gaps with the words and phrases in the box.

satellites term positioning
satellite navigation systems
Doppler coverage

GPS, GNSS, GLONASS or DORIS?

These acronyms refer to all types of 1)…. They provide geo-spatial 2)… across the earth using a system of 3)…. A system with global 4)… is known as a global navigation satellite system (GNSS). At present, there are only two GNSS in the world. These are the USA's global positioning system (GPS) and the Russian GLONASS (global navigation satellite system). China are expecting their Compass

navigation system to be a global system by 2020 and the European Galileo positioning system should go global shortly after this date.

GNSS is therefore a generic 5)… for systems such as GPS and GLONASS.

DORIS is the 6)… Orbitography and Radio positioning integrated by satellites system, which is a navigation system being developed by France.

Reading

1.The article below is about GLONASS, the Russian navigation system. Before you, read try to predict what issues will be discussed in the text choosing the statements from those given below.

- Purpose of GLONASS
- GLONASS architecture
- History of GLONASS
- The GLONASS signal components
- GPS/GLONASS integration
- Difference between two systems
- Problems with GPS/GLONASS integration
- Advantages of GLONASS over GPS
- GLONASS applications

Read the text to check if your predictions were right.

GLONASS Satellite System

GLONASS is an all-weather global navigation satellite system developed by the Russian Federation. The GLONASS satellite system has much in common with the GPS system and provides reliable positioning, navigation, and timing services to users on a continuous worldwide basis freely available to all. It can be considered as an alternative and complementary to other GNSS systems such as the United States' GPS, the Chinese BeiDou navigation system and the planned Galileo system of the European Union.

The first Soviet navigation spacecraft “Cyclone” was launched into orbit in 1967.This was the beginning of the first Soviet low orbit navigation system, called “Cicada”. It consisted of four satellites placed in circular orbits at an altitude of 1000 km and an inclination of 8300 and provided positioning data within several hundred meters. Since the requirements to space navigation were constantly increasing, low-orbit systems could not comply with the needs of all potential users. Thus, flight tests of high altitude (20000 km) satellite navigation system, called GLONASS were started in 12 October 1982 with the launch of the Kosmos-1413, Kosmos-1414, and Kosmos-1415. In 1993, the Russian Federation formally declared the system operational, and in 1995, the system was brought to its optimal status of 24 operational satellites.

Similar to GPS, each GLONASS system Space Vehicle (SV) "GLONASS" and "GLONASS-M" transmits a radio signal that has a number of components: two L-band carriers (L1 ~ 1, 6 GHz, L2 ~ 1,25 GHz), C/A-code on L1, P-code on both L1 and L2 and a navigation message. GLONASS relies on the Frequency Division Multiple Access (FDMA) technique instead of the CDMA used by other GNSS systems such GPS or GALILEO. Each satellite transmits signals on its own carrier frequency. The satellite pairs, however, are placed on the opposite sides of the Earth (antipodal), which means that a user cannot see them simultaneously. GLONASS codes are the same for all satellites. Therefore, GLONASS receivers use the frequency channel rather than the code to distinguish the satellites. The chipping rates for the P-code and the C/A-code are 5.11 and 0.511 Mbps, respectively. The GLONASS navigation message is a 50-bps data stream, which provides, among other things, the satellite ephemeris (precise orbital information) and the channel allocation.

GLONASS is comprised of three segments: a GLONASS Space Segment (SS), a GLONASS Ground Segment (CS), and a GLONASS User Segment (US).

According to the GLONASS Interface Control Document, the GLONASS Space Segment is composed of 24 satellites. Eight satellites are arranged in each of three orbital planes. The satellites operate in approximately circular orbits at an altitude of 19,100 km, an

inclination of 64.80 and with the orbital period of 11 hours 15 minutes. The spacing of the satellites allows providing continuous and global coverage of the terrestrial surface and the near-earth space.

GLONASS Ground Segment includes the System Control Center and the network of the Command and Tracking Stations that are located throughout the territory of Russia. The control segment provides monitoring of GLONASS constellation status, correction to the orbital parameters and navigation data uploading.

GLONASS User Segment consists of the user receivers, which compute coordinates, velocity and time using the GLONASS navigation signals.

Two services are available from GLONASS system:

The Standard Positioning Service (or Standard Accuracy Signal service) is an open service, free of charge for worldwide users. The navigation signal was initially provided only in the frequency band G1, but the GLONASS-M transmits also a second civil signal in G2.

The Precise Positioning Service (or High Accuracy Signal service) is restricted to military and authorized users. Two navigation signals are provided in the two frequency bands G1 and G2.

GPS and GLONASS systems may be integrated to improve geometry and positioning accuracy, particularly under poor visibility such as in urban areas. There are, however, two problems with GPS/GLONASS integration. The first one is that both systems use different coordinate frames to express the position of their satellites. GPS uses the WGS 84 system, while GLONASS applies the Earth Parameter System 1990 (PZ-90). The two systems differ as much as 20 meters on the Earth's surface. The transformation parameters between the two systems may be obtained by observing reference points in both systems simultaneously. The second problem with GPS/GLONASS integration is in using different reference times. The offset between the two time systems changes slowly and reaches several tens of microseconds. One way of determining the time offset is by treating it as an additional variable in the receiver solution.

Comprehension

1. Find words in the text with similar meaning to the following words and phrases.

1. Contain
2. Height
3. Roughly
4. At the same time
5. Put in an order
6. Differentiate
7. Enhance
8. Making a good combination
9. Obey a rule or law
10. Discrepancy
11. Completely different

2. Match words in A with words in B to make collocations and explain in relation with what these collocations are used in the text.

A	**B**
a. orbital	**1.** channel
b. chipping	**2.** satellite
c. urban	**3.** stream
d. frequency	**4.** period
e. operational	**5.** time
f. satellite	**6.** side
g. reference	**7.** area
h. data	**8.** frame
i. coordinate	**9.** ephemeris

j. opposite **10.** rate

3. According to the text, are the following statements true or false? If they are false, explain why.

1. GLONASS and GPS are completely different systems; they do not have any similar features.
2. The development of high altitude satellite systems began because low-orbit systems could not meet increasing requirements to space navigation.
3. Each GLONASS satellite transmits a signal containing two carriers, two digital codes and a navigation message.
4. GLONASS includes three segments: a space segment, a ground segment and a user segment.
5. GPS/GLONASS integration is hardly feasible.
6. GLONASS receivers use the code rather than the frequency channel to distinguish the satellites.
7. GPS/GLONASS integration allows improving geometry and positioning accuracy.

4. Write a summary of the text in which outline the GLONASS purpose, features and architecture.

Language Focus

1. Any system needs improving and upgrading. Evidently, the GLONASS performance has not achieved the level of the GPS capability yet because of several factors, on-board atomic clock imperfections, the number of satellites in the constellation, ground monitoring and control limitations are among them.

Work in groups and brainstorm features that could improve the GLONASS efficiency. Make a list of feasible solutions.

Compare your ideas with those of other students. Do you have similar or different solutions?

2. To check your ideas read the extract about GLONASS modernization. While reading, choose the correct form in each case. There is an example at the beginning (0).

GLONASS Modernization

GLONASS Space Segment modernization began with the launch of the second generation of satellites, *(0) known/knowing* as GLONASS-M, in 2003. These satellites had some improvements, including new filters that *1) permitting/permitted* the reduction of out-of-band emissions and *2) enhancing/enhanced* on-board clock stability.

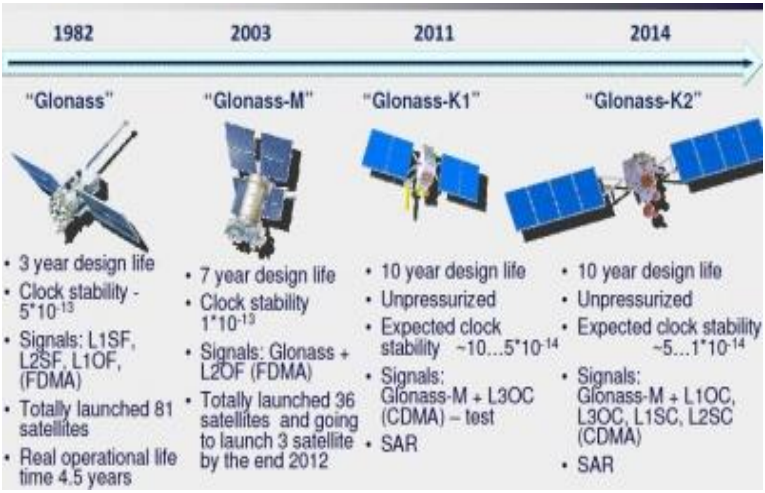
Aiming to provide *3) better/best* accuracy, multipath resistance and greater interoperability with GPS and future GALILEO and other GNSS Systems, new GLONASS-K satellites will transmit CDMA (code division multiple access) signals *4)in/with* addition to the system's traditional FDMA (frequency division multiple access). The GLONASS L3 signal is *5) centered/centering* at 1207.14 MHz, the same frequency as Galileo/BeiDou signal E5b, in the region allocated to the Aeronautical Radio 1 Navigation Service (ARNS). These bands are especially suitable for Safety-of-Life applications because no other users *6) allow/are allowed* to interfere *7) on/with* their signals.

The first satellite of the third generation, GLONASS-K1, *8) launched/was launched* on February 26, 2011. GLONASS-K1 satellites *9) have/are having* a ten- *10) year/years* design life and transmit a CDMA civil signal at L3 frequency in the 1205 MHz band.

The future GLONASS-K2 satellites to *11)be/being* launched in 2014 have a 10-year design life, a higher clock stability and feature four additional CDMA signals as well as the original FDMA signals.

A *12) modernized/modernizing* GLONASS-K satellite (GLONASS-KM) could transmit legacy FDMA signals on L1 and L2 and CDMA signals on L1, L2, and L3. It could also transmit CDMA signals on the GPS L5 frequency and Galileo signal E5a at 1176.45 MHz.

By 2020, the system is scheduled to have all satellites transmitting *13) either/both* the CDMA and FDMA signals.



Space Segment

As for the ground segment, there are plans to enhance it *14) with/by* adding fifteen new reference stations, with six of them located outside the Russian territory.

The development of both the GLONASS tracking capabilities and the steady increase in the number of GLONASS satellites *15) has had/has been having* a positive influence on the accuracy of the GLONASS orbits and clocks.

To improve the interoperability with other GNSS systems, GLONASS coordinate system *16) has matched/has been matched* with the International Terrestrial Reference System (ITR), an international standard.

3. Another system that is likely to become a global navigation system in the future is the Galileo system being developed by Europe.

The text below is about the Galileo system. Read the text and choose the best sentence (A-H) given below to fill in the blanks in the text. Two of the suggested options do not fit at all.

Future European Global System

The Galileo system is a European-controlled, satellite-based global navigation system. **1)** _____.

Three different constellation types were investigated to ensure the optimum Galileo architecture, namely low Earth orbits (LEO), medium Earth orbits (MEO) and inclined geo-synchronous orbits (IGSO). Following this study, a constellation of 30 MEO satellites was adopted. **2)** _____. This selection ensures that more uniform performance is obtained for all regions (i.e. independent of the region latitude).

Galileo is compatible at the user level with the GPS and GLONASS systems. **3)** _____.

With positioning accuracy to one meter, the freely accessible Galileo Open Service (OS) provides positioning, timing and synchronization information significant for satellite radio navigation applications. **4)** _____.

The Galileo Open Service is accessible through the signals at L1, E5a and E5b frequencies. Several combinations are also possible, such as a dual frequency service based on L1 and E5a or single frequency services (at L1, E5a, E5b or E5a and E5b together), and even triple frequency services using all the signals together (L1, E5a and E5b), which can be exploited for very precise applications.

	Galileo Open Service (positioning & timing)	
	Single Frequency (SF)	Dual Frequency (DF)
Coverage	Global	
Accuracy (95%)	Horizontal: 15 m	Horizontal: 4m
	Vertical: 35 m	Vertical: 8m

Availability	99.8 %	
Timing Accuracy UTC/TAI	N/A	30 ns
Ionosphere Correction	Based on SF Model	Based on DF Measurements
Integrity	No	

Service Performances for Galileo Open Service

5) _____. Each navigation frequency will include two ranging code signals (in-phase and quadrature). Data are added to one of the ranging codes while the other "pilot" ranging code does not contain any data for more precise and robust navigation measurements.

The introduction of Galileo operational service is implemented gradually, in a number of phases. **6)** _____. At this stage, however, accuracy and availability have not reached their optimum level yet.

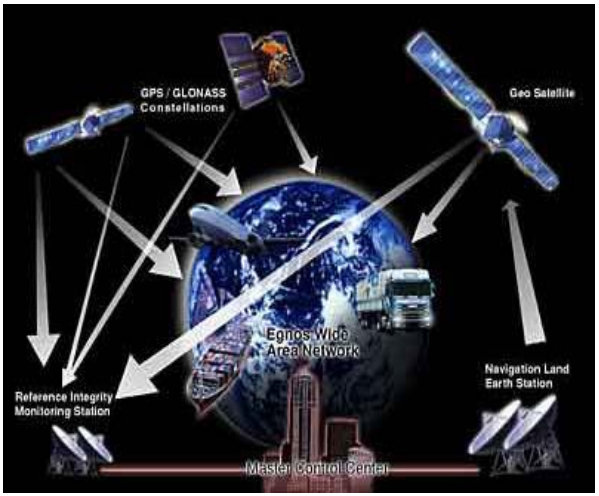
A. The timing service is synchronized with UTC when used with receivers in fixed locations and can be useful for network synchronization or scientific applications.

B. During the Initial Operational Capability (IOC) phase, mainly search and rescue services are provided.

C. As well, it includes determining the signal characteristics.

D. It will provide a range of guaranteed services to users equipped with Galileo receivers.

E. The Open Service signals are separated in frequency to permit the correction of errors caused by ionosphere effects by differentiating the ranging measurements made at each frequency.



F. The satellites will be evenly distributed over three orbital planes at an altitude of about 23,000 km.

G. However, unlike GPS and GLONASS, Galileo will provide two levels of services: a basic, free-of-direct-charge service and a chargeable service that offers additional features.

H. A European political body, independent of Galileo management, will have the authority to take the proper measures in the event of a crisis.

4. The current satellite-based global navigation systems, GPS and GLONASS, do not meet all of the civil aviation requirements. To overcome these limitations regional augmentation systems are developed. One of these systems, European Geostationary Navigation Overlay System (EGNOS), is developed by Europe.

Read the extract about EGNOS. Use the words in brackets to form a word that fits in the gap in the sentence.

The European navigation system is intended to augment the two *1) (operate)* satellite navigation systems - the American GPS and the Russian GLONASS, and make them *2) (suit)* for safety-critical *3) (apply)* such as flying aircraft or navigating ships through narrow channels. EGNOS consists of three geo-stationary satellites and a network of ground stations. The system transmits a signal containing *4) (inform)* on the *5) (rely)* and *6) (accurate)* of the positioning signals sent out by GPS and GLONASS. It allows users in European countries to determine their position within 5 meters. EGNOS is a joint venture

of ESA (European Space Agency), the European Commission, and the European Organization for the Safety of Air Navigation. It is Europe's *7) (contribute)* to the first stage of creating a global navigation system and is viewed as a precursor to the Galileo satellite navigation system. It was announced on July 28, 2005, that the transfer of EGNOS operations from ESA to the operating company, European Satellite Services Provider, had begun.

Speaking

1. Imagine that you are going to participate in an international scientific conference dedicated to advances in electronic technologies. One of the issues to be discussed is the satellite communication perspectives. You have been asked to give a ten-minute talk on satellite navigation.

Work with a partner. Do some research on the GLONASS perspectives and prepare your talk. Think of visual aids (e.g. graphs, drawings, photos) to make your talk more informative.

2. Work in groups.

Group A. You are speakers. Give your talk. Be prepared to answer an audience's questions.

Group B. You are participants in the conference. Brainstorm questions you could ask about the Russian navigation system.

Role-play your sessions.

Writing

1. Write an article for a scientific journal on satellite navigation perspectives.

Grammar: The Infinitive Constructions

There are three infinitive constructions in English.

1. The Objective with the Infinitive (Complex Object).

2. The Nominative with the Infinitive (Complex Subject).

3. The for-to-Infinitive Construction (For+ Objective+ Infinitive).

The Objective with the Infinitive Construction is a syntactic structure in which the infinitive is in the predicate relation to a noun in the common case or a pronoun in the objective case. This construction functions as a complex object.

The Objective with the Infinitive Construction is used after

1) the verbs denoting **sense perception** (*to hear, to see, to watch, to feel, to observe* – the infinitive is used without the particle "to" after these verbs)

I *heard* ***somebody speak*** in the next room.

Nobody *noticed* ***him leave*** the room.

However, the present participle is used instead of the infinitive in such constructions to stress that the action is in progress. E.g., I saw him crossing the street. I heard her singing.

2) the verbs denoting **mental activity** (*to know, to think, to consider, to believe, to suppose, to expect, to find, to state, to note, to trust*)

We *consider* ***him to be*** the best authority in the country.

We *believe* ***them to have finished*** their research.

3) the verbs denoting **wish and intention** (*to want, to wish, to desire, to mean, to intend*)

They *wanted* ***the device to be examined*** carefully by experts.

We *would like* ***him to participate*** in the conference.

4) the verbs and expressions denoting **feeling and emotion** (*to like, to dislike, to love, to hate, cannot bear*)

I *like* ***you to keep*** everything tidy.

5) the verbs denoting **order and permission** (*to order, to allow, to let*), the verbs of **compulsion** (*to make, to cause, to get, to force*)

The noise *caused* ***her to awake***.

The director *ordered* ***the documents to be sent off*** immediately.

The Nominative with the Infinitive Construction (Complex Subject) is a complex in which the infinitive is in the predicate relation to a noun in the common case or a pronoun in the nominative case, which is the subject of the sentence. The infinitive here stands after the predicate that, in the majority of cases, is in the passive voice. Thus, this construction may be called "split" since its parts are detached. When translating this construction into Russian we usually begin with the predicate.

The Subjective Infinitive Construction is used with the following groups of verbs in the passive voice

1) the verbs denoting **sense perception** (*to see, to hear,* etc.)

***She** was heard **to mention** your name.*

2) the verbs denoting **mental activity** (*to think, to consider, to know, to expect, to believe*, etc.)

***Heat** was thought **to be** a material substance.*

***Radio** is known **to have been invented** in Russia.*

3) with the expressions *to be likely/unlikely, to be sure, to be certain, to be bound* in the function of the predicative

These ***difficulties** are certain **to arise** in carrying out the experiment.*

***He** is unlikely **to have made** such a mistake.*

4) with the verbs *to seem, to appear, to happen, to chance, to prove, to turn out*, which are used in the active voice

***He** proved **to be** a talented designer.*

***The house** seems **to have been damaged** by the earthquake.*

The for-to-Infinitive Construction is a construction in which the infinitive is in the predicate relation to a noun in the common case or a pronoun in the objective case preceded by the preposition *for*.

The functions of the for-to-Infinitive Construction are as follows:

1) the subject (often with the introductory *it*)

It would be difficult ***for me to ask*** about it./ ***For me to ask*** would be difficult.

It is important ***for us to finish*** the experiment in time.

2) the predicative

That was ***for him to find out***.

3) the object

Nearly a month is required ***for the Moon to circle*** the Earth.

4) the attribute

It is not the right time ***for us to speak*** about it.

5) the adverbial modifier

a) of purpose

For this phenomenon to be explained we must get some new information.

b) of result

The temptation was too great ***for me to resist***.

1. Identify the type of an infinitive construction used in the following sentences.

1. The unsatisfactory operation of the testing installation forced the investigator to modernize it.
2. The human voice is known to contain higher frequencies.
3. Achievements in radio engineering are believed to have laid the foundation for further progress in the area of long-distance communication.
4. Lasers are sure to do some jobs more efficiently and economically than other devices.
5. The engineer considered the amplifier to be powerful enough for the required operation.
6. They are supposed to have completed their graduation program.

7. The scientists seem to have been investigating the phenomenon since last year.
8. The application of integrated circuits allowed engineers to reduce the dimensions of electronic devices and increase their reliability.
9. The early discoveries in nuclear science showed the atomic nucleus to be a vast source of energy.
10. The combination of electric and magnetic fields causes the electrons emitted from the cathode to move in nearly circular paths in the region between cathode and anode.
11. Lasers appeared to be highly useful for solving the problems of controlled thermonuclear reaction and communication.
12. Most physicists believed in the latter half of the 19th century cathode rays to be charged particles.
13. A current that always flows in one direction along a wire is said to be a direct current.
14. Further design improvements are likely to increase the device reliability appreciably.
15. An insulated wire would not allow the current to escape.
16. Whatever the application, the essential part of a feedback system seems to be control of the input.
17. The hydrogen atom was the object of the first theoretical investigation because as the lightest of all atoms it was assumed to have the simplest structure.
18. The term "radar" is known to be composed of the first letters of "radio, detection and ranging". It happens to reflect its basic principle that is the location of an object at a distance.
19. A laser is a device that stimulates the electrons of a light-producing material to vibrate simultaneously to give off a light with tremendous energy.

20. In the electromagnetic theory of radiation the atom is supposed to be similar to the antenna of a radio transmitter, although much smaller and radiating a much higher frequency.
21. When the energy of the photon is sufficiently great to remove the electron completely, the atom is said to be ionized.
22. Advanced techniques to modernize the manufacturing process are certain to be made use of.
23. The application of cybernetics to electronic computers is known to be leading to a better understanding of the brain working and conversely a deeper knowledge of the "human mechanism" is expected to lead to the development of machines of almost human capability.
24. Newton stated that the force, which makes objects fall towards the Earth, is only a special case of a general attraction between any two masses.

2. In the sentences below, define the function of for-to-infinitive complex.

1. It is important for the model to be accurate but simple enough.
2. For the sound to arise it is necessary to have a sound source and a medium to travel through.
3. The frequency of transmission was low enough for reflection to take place from those areas of the ionosphere illuminated by the sun.
4. The condition was for all the participants to send applications two weeks in advance.
5. There was nothing for us to do but wait.
6. For a battery to be charged it is only necessary to maintain an electric current in it in a direction opposite to that in which the current flows when the cell is in use.

7. Before the advent of an electronic computer, it was not uncommon for the complete analysis of a single molecule to take two or three years.
8. The results were not satisfactory enough for a gap in the record to be adequately filled.
9. In order for the atoms to rearrange themselves in a crystal lattice many of the bonds would have to be broken and then reestablished in another configuration.
10. There are prospects for lasers to be used in long distance communication and for transmitting energy to space stations.
11. It is necessary for the signal-to-noise ratio to be as optimal as possible.
12. For a sound to be heard by the human ear it should be between the frequencies of approximately 20 cycles and 15,000 cycles.
13. High noise level with this circuit makes it difficult for useful signals to be distinguished.
14. It is possible for vacuum tubes to convert part of their energy into visible light.

3. Change the sentences using either Complex Object or Complex Subject.

0. He supposes that the work will be completed today. He supposes ***the work to be completed*** today.

It is known that this scientist has made an important discovery. ***This scientist*** *is known* ***to have made*** an important discovery.

1. It seems that these devices have excellent performance.
2. Researchers expect that the results will agree with theoretical predictions.
3. It appears that these approximations are accurate enough for most practical design details.

4. We heard how the scientist explained the process of amplifying signals.
5. It seems that the design has already been improved.
6. The manager believed that the staff knew about the meeting.
7. His parents expected that he would follow in their steps in career.
8. We are sure your project will be a success.
9. They considered that the idea was reasonable.
10. She had to change her plans because of the unexpected circumstances (to cause).
11. I do not think her parents will approve of her choice.
12. It seems that she has been working at her course paper since spring but it appears she has still a lot to do.
13. It is expected that the committee will approve the initiative.
14. Everyone knows that he is a responsible person; it is hard to believe he has done it.
15. If you follow my advice, you will succeed without fail.
16. It appeared he had been long out of practice.
17. It was considered that he was working at that problem then.
18. It proved the experiment was a failure.
19. It is reported that the commission is conducting an investigation of the incident.
20. The ancients thought electricity was invisible fluid.
21. It does not appear there is a promising approach to the solution of the problem.
22. It is known that he has been working in this area for many years.
23. She believed we had been informed of their arrival.

24. It is hardly possible that the theory could give results, which are in good agreement with observation.
25. It appears the manuscript was written in Greek.
26. Modern theory considers that at extremely high temperatures molecules break up to form atoms or ions, which are electrically charged atoms or portions of molecules.

Glossary

Units 1-2

Alphanumerical adj. – буквенно-цифровой
binary format – двоичный, бинарный формат
bit stream – поток битов (двоичных разрядов)
continuous adj. – непрерывный, постоянный
convert v– преобразовывать
discrete adj. – дискретный, отдельный
duplex network – дуплексная сеть (схема), позволяющая передавать информацию в двух направлениях одновременно
frequency-division multiplexing – уплотнение по частоте
haul n – протяженность линии связи; расстояние, дальность
increment n –возрастание, увеличение; приращение,
шаг (приращения)
loop n – контур, (замкнутая) цепь
multiplex n, v–1) многократный, множественный,
мультиплексный, сложный;
2) мультиплексировать, уплотнять (каналы)
Noise immunity– помехоустойчивость, помехозащищенность
Quantization n–квантование, дискретизация; разбиение (данных) на подгруппы
Resolution n – разрешение, разрешающая способность
Serial transmission– последовательная передача (метод передачи информации, при котором биты передаются
последовательно, вместо одновременной (параллельной) передачи по нескольким линиям)
simplex network– симплексная, односторонняя сеть (схема), позволяющая передавать данные только в одном направлении
switch v, n – выключатель, переключатель, коммутатор; переключать
time-division multiplexing – временное уплотнение
trunk n –магистральная линия, магистраль (базовый канал, соединяющий два пункта, каждый из которых является коммутационным центром или точкой распределения)

Unit 3

AES encryption– симметричный алгоритм блочного шифрования
Broadband n – широкополосная связь, широкополосное соединение
Data transfer rate – скорость передачи данных
DSL – технология высокоскоростной передачи данных по телефонным линиям
Duty cycle – рабочий цикл
Internet of Things– интернет вещей (технология соединения различных устройств в одну сеть для передачи и хранения информации)
Latency n – время (период) ожидания
M2M (machinetomachine) – межмашинноевзаимодействие
Mesh network – ячеистая сеть (топология)
Spread spectrum – технология передачи сигналов по каналу с использованием нескольких частот
TCP/IP network – сеть, функционирующая на основе протокола TCP/IP

Unit 4
Angular momentum – момент импульса (количества движения)
Magnetic moment – магнитный момент
magnetoresistancen –магнитосопротивление
relaxation time – время релаксации
spin n – спин, характеристика вращения электрона в атоме
spin polarization – поляризация спина

Units 5-6
carrier frequency – несущая частота
constellation – совокупность, группа; созвездие
coverage n–охват, покрытие, зона действия, рабочая зона
Doppler shift– доплеровский сдвиг (смещение)
Eccentricity n – эксцентриситет
Elevation angle – угол возвышения
inclination – величина отклонения; наклон, угол наклона

navigation message – сообщение, содержащее навигационные данные
orbital period – период обращения
reference time – начало отсчета времени; начальный момент времени; опорная точка отсчета времени
satellite almanac – календарь, альманах спутника
satellite ephemeris – спутниковые эфемериды, астрономические таблицы
semi-major axis – большая полуось
sidereal hour – час звездный
tracking – слежение, сопровождение; прокладка маршрута

References

1. Kuphaldt T.R. Digital Data Communication Theory (электронный ресурс) – www.iamechatronics.com/notes/general-engineering/280-digital-data-communication-theory
2. Mathur A. Difference between Analog and Digital Signals (электронный ресурс) – http://readanddigest.com/difference-between-analog-and-digital-signals
3. Ray B. Five Types of Wireless Technology for Internet of Things (электронный ресурс) –www.link-labs.com
4. Sankar Das Sarma Spintronics (электронный ресурс) – www.physics.umd.edu
5. www.researchgate.net
6. www.spintronics-info.com
7. El-Rabbany A. Introduction to GPS: The Global Positioning System – Artech House Publishers. Boston. London – доступ: https://books.google.ru
8. Galileo Open Service (электронный ресурс) – www.navipedia.net/index.php/Galileo_Open_Service_(OS)
9. GLONASS. General Introduction (электронный ресурс) – www.navipedia.net/index.php/GLONASS_General_Introduction
10. www. thefreedictionary.com

Учебное издание

Луценко Светлана Александровна

ЭЛЕКТРОНИКА: ПЕРСПЕКТИВЫ РАЗВИТИЯ
(ELECTRONICS: PROSPECTS FOR EVOLUTION)

Учебное пособие

Редактор А.В. Ярославцева
Компьютерная вёрстка А.В. Ярославцевой

Подписано в печать 12.11.2018. Формат 60х84 1/16.
Бумага офсетная. Печ. л. 10,0.
Тираж 25 экз. Заказ . Арт. – 7(Р4У)/2018.

ФЕДЕРАЛЬНОЕ ГОСУДАРСТВЕННОЕ АВТОНОМНОЕ
ОБРАЗОВАТЕЛЬНОЕ УЧРЕЖДЕНИЕ ВЫСШЕГО ОБРАЗОВАНИЯ
«САМАРСКИЙ НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ ИМЕНИ АКАДЕМИКА С.П. КОРОЛЕВА»
(САМАРСКИЙ УНИВЕРСИТЕТ)
443086 Самара, Московское шоссе, 34.

Изд-во Самарского университета.
443086 Самара, Московское шоссе, 34.