# MODULE II

# FUNDAMENTALS OF ENGINEERING

## Unit 3

## ENGINEERING

**Topical vocabulary**

| | |
|---|---|
| 1. engineering (n) | инженерное дело |
| engineer (n) | инженер |
| 2. challenge (n) | проблема, задача |
| 3. satisfy requirements (v) | удовлетворять требованиям |
| complexity (n) | сложность |
| cost (n) | стоимость |
| ease of fabrication (n) | простота изготовления |
| performance (n) | производительность |
| safety (n) | безопасность |
| 3. solution (n) | решение |
| desirable (adj) | желательный |
| efficient (adj) | эффективный |
| feasible (adj) | осуществимый |
| optimum (adj) | оптимальный |
| reliable (adj) | надёжный |
| simple (adj) | простой |
| 4. concern oneself with (v) | заниматься (чем-либо), иметь дело с |
| approach (v) | подходить (к проблеме) |
| apply (v) | применять |
| boost (v) | повышать |
| construct (v) | сооружать |
| design (v) | проектировать |
| determine (v) | определять |
| employ (v) | задействовать |
| estimate (v) | оценивать |
| focus (v) | концентрироваться |
| implement (v) | реализовывать, воплощать |
| improve (v) | улучшать |
| increase (v) | увеличивать |
| lower (v) | снижать |
| maintain (v) | эксплуатировать, обслуживать |
| refine (v) | обрабатывать, очищать |

| | |
|---|---|
| utilize (v) | пользоваться |
| 5. equipment (n) | оборудование |
| 6. natural resources (n) | природные ресурсы |
| raw materials (n) | сырьё |
| 7. source of energy (n) | источник энергии |
| fossil fuel (n) | ископаемое топливо |
| coal (n) | уголь |
| natural gas (n) | природный газ |
| petroleum (n) | нефть |
| falling water (n) | падающая вода |
| nuclear fission (n) | расщепление атомного ядра |
| sunlight (n) | солнечный свет |
| wind (n) | ветер |
| 8. discipline (n) | дисциплина, отрасль знаний |
| subfield (n) | подобласть |
| 9. civil engineering (n) | строительство |
| infrastructure item (n) | элемент инфраструктуры |
| bridge (n) | мост |
| dam (n) | плотина, дамба |
| railway (n) | железная дорога |
| sea defense (n) | защита от наводнений |
| tunnel (n) | туннель |
| water supply system (n) | система водоснабжения |
| 10. mechanical engineering (n) | машиностроение |
| energy conversion (n) | преобразование энергии |
| manufacturing (n) | промышленное производство |
| aerospace (adj) | аэрокосмический |
| aircraft (n) | летательный аппарат |
| automotive (adj) | автомобильный |
| shipbuilding (n) | кораблестроение |
| 11. electrical engineering (n) | электротехника |
| power plant (n) | электростанция |
| power source (n) | источник питания |
| 12. chemical engineering (n) | химическая технология |
| chemical (n) | химикат |
| pharmaceutical (n) | фармпрепарат, лекарственное средство |
| food processing (n) | производство пищевых продуктов |
| 13. industrial engineering (n) | организация промышленного производства |
| 14. adhere (v) | соблюдать |
| comply (v) | подчиняться |

| | |
|---|---|
| rule (n) | правило |
| regulation (n) | предписание, регламент |
| schedule (n) | расписание |
| 15. load (n) | нагрузка |
| fatigue test (n) | испытание на усталостное разрушение |
| stress test (n) | испытание под нагрузкой |
| 16. artificial intelligence (AI) (n) | искусственный интеллект (ИИ) |
| connectivity (n) | обеспечение связи |
| cybersecurity (n) | кибербезопасность |

**3.1 Read the quote and try to explain the engineer's view of the glass-half-full / glass-half-empty problem**

"A pessimist says the glass is half empty, an optimist says the glass is half full, and an engineer says the glass is too big." (*Scott Edward Skjefte*)

**3.2. Read the text and fill in the table**

| **What I knew before reading the text** | **What I learned from the text** | **What made me look at what I knew from a different angle** |
|---|---|---|
| 1. … | 1. … | 1. … |

## WHAT IS ENGINEERING?

Engineering is the art of the possible. It's applying skill and creative thinking to solving the world's biggest challenges. From climate change to connectivity, clean water to cybersecurity, engineering touches every aspect of our lives. Engineers are the catalyst behind what's called the "built environment": the homes we live in, the buildings we work in, and the roads, bridges, rail networks, and airports that get us there. Engineers design how our world works and how we can bring it closer together.

Engineers approach every project with the mindset of, "How can I make this better… more efficient… safer… greener?" Engineering solutions must satisfy conflicting requirements. Usually, efficiency costs money, safety adds to complexity, and improved performance increases weight. The engineering solution is the optimum solution, the end result that, taking many factors into account, is most desirable. It may be the most reliable within a given weight limit, the simplest that will satisfy certain safety requirements, or the most efficient for a given cost. In many engineering problems the social and environmental costs are significant.

Engineers employ two types of natural resources – materials and energy. Materials are useful because of their properties: their strength, ease of fabrication, lightness, or durability; their ability to insulate or conduct; their chemical, electrical, or acoustical properties.

Important sources of energy include fossil fuels (coal, petroleum, natural gas), wind, sunlight, falling water, and nuclear fission. Since most resources are limited, engineers must concern themselves with the continual development of new resources as well as the efficient utilization of existing ones.

Engineering is a field composed of relentless problem solvers – and there are a host of disciplines and subfields from which to choose. Whether you are fascinated by the wonders of AI and drone technology or you want to leverage your organizational skills into a project manager role, there is something within the engineering field for everyone. Here are just a few:

**Civil** engineering involves designing, building, and also maintaining structures such as infrastructure items. The term *infrastructure* refers to for example, railways, hospitals, water supply systems, bridges, tunnels, buildings, dams, sea defenses, and other systems and structures that we tend to take for granted.

**Mechanical** engineers work in the design, creation, and implementation of mechanical systems. Much of their work involves studying objects in motion.

They are key employees in a number of different industries including manufacturing, energy conversion, automotive, aerospace, shipbuilding, construction, medical devices, railways, and power.

**Electrical** engineers focus on technology that uses electricity as its power source. They work on electrical devices, systems, and components. While one person might be working on something tiny, such as a microchip, another could be building a giant power plant.

**Chemical** engineers are involved in creating industrial chemicals, pharmaceuticals, as well as food processing. They design and implement the systems, processes, and equipment for refining raw materials and processing chemicals to make products that consumers, businesses, and other entities use.

**Industrial** engineers, as the name suggests, work in industry. More specifically, they focus on boosting efficiency, lowering costs, improving product quality (or service quality), and health and safety in the workplace.

They also implement strategies to make a company or its factory environmentally friendly. *Compliance* is also the focus of industrial engineers. *Compliance* refers to adhering to or complying with (obeying) specific rules and regulations.

### 3.3 Answer the following questions

1. Why is engineering referred to as ‘the art of the possible’?
2. Which aspects of people’s lives does engineering touch? Name at least five.
3. What are the characteristics of the engineering solution?
4. What kind of resources do engineers employ? What affects their choice?
5. What products of engineering can you see around yourself right now? Name at least five. Which engineering fields are concerned with them?
6. Which engineering professionals are qualified to work in nearly any industry? Why?

### 3.4 Find the English equivalents of the following phrases in the text

1. применение навыков и творческого мышления для решения самых сложных задач в мире
2. затрагивать все аспекты нашей жизни
3. увеличивать сложность
4. повышенная производительность
5. учитывая многие факторы
6. наиболее надежный при заданном предельном весе
7. соблюдать определенные требования безопасности
8. использовать два вида природных ресурсов
9. увлекаться чудесами искусственного интеллекта и беспилотных технологий
10. системы водоснабжения
11. воспринимать как само собой разумеющееся
12. включать в себя изучение движущихся объектов
13. переработка сырья
14. как следует из названия
15. соблюдение определенных правил и предписаний

### 3.5 Find words in the text whose meaning is similar to the meaning of the following words

| | | | |
|---|---|---|---|
| 1. problem | 4. to utilize | 7. to include | 10. transformation |
| 2. need | 5. characteristic | 8. object | 11. to concentrate |
| 3. productiveness | 6. area | 9. producing | 12. to fulfill |

### 3.6 Find words in the text whose meaning is opposite to the meaning of the following words

| | | | | |
|---|---|---|---|---|
| 1. similar | 3. simplicity | 5. fusion | 7. beyond | 9. to reduce |
| 2. danger | 4. to conduct | 6. bored | 8. giant | 10. to increase |

### 3.7 a) Match the adjectives / nouns and the nouns to form all possible word combinations. Make sentences of your own with the word combinations

| Adjective / Noun | Noun |
|---|---|
| 1. creative | a) change |
| 2. climate | b) conversion |
| 3. conflicting | c) devices |
| 4. optimum | d) fission |
| 5. natural | e) fuels |
| 6. chemical | f) manager |
| 7. fossil | g) materials |

| | |
|---|---|
| 8. nuclear | h) plant |
| 9. efficient | i) processing |
| 10. project | j) properties |
| 11. energy | k) requirements |
| 12. electrical | l) resources |
| 13. power | m) solution |
| 14. food | n) thinking |
| 15. raw | o) utilization |

**b) Match the verbs and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Verb | Noun |
|---|---|
| 1. to apply | a) weight |
| 2. to solve | b) strategies |
| 3. to satisfy | c) skill |
| 4. to cost | d) rules |
| 5. to increase | e) resources |
| 6. to employ | f) requirements |
| 7. to process | g) quality |
| 8. to boost | h) money |
| 9. to lower | i) efficiency |
| 10. to improve | j) costs |
| 11. to implement | k) chemicals |
| 12. to obey | l) challenges |

**3.8 Find the corresponding prepositions for the following verbs in the text. Make sentences of your own where the verbs are used in combination with the prepositions**

1. to add _____

2. to concern oneself / to be concerned _____

3. to choose _____

4. to fascinate / to be fascinated _____

5. to work _____

6. to involve someone / to be involved _____

7. to focus _____

8. to adhere _____

9. to comply _____

**3.9 Match the words / phrases and their meanings**

| Word / phrase | Meaning |
|---|---|
| 1. to apply | a) a useful or valuable possession or quality of a country, organization, or person |
| 2. to be in charge | b) to prepare, change, or treat food or natural substances as a part of an industrial operation |
| 3. to be concerned with | c) to make use of something for a particular purpose |
| 4. to design | d) a list of planned activities or things to be done showing the times or dates when they are intended to happen or be done |
| 5. to estimate | e) to keep in good condition and working order |
| 6. feasible | f) to guess or calculate the cost, size, value, etc. of something |
| 7. to maintain | g) to deal with |
| 8. to process | h) to create or construct according to plan |
| 9. resource | i) to have control of or be responsible for someone or something |
| 10. schedule | j) able to be done in practice |

**3.10 Complete the conversation between a radio program host and the program's guest with words from the list below. Try to summarize the content of the conversation in 50 words or less**

**challenge cost designing engineer feasibility ideas improve loads mechanical practical schedule solutions stress training work**

**Host (H):** For our next guest, I'd like to welcome to the program Lindsey Barone, head of engineering at Swift Aerospace.

**Guest (G):** Good morning, everyone.

**H:** Lindsey, you're an **1** _____, but why did you become one? What got you interested?

**G:** Well, from a young age I was always interested in how things **2** _____. I chose engineering as a career because I wanted to make things better. Engineering isn't just about testing theories and building models. It's about **3** _____ new products and finding new uses for old products. I want to **4** _____ the way the world works.

**H:** Mmm, interesting. And could you tell me a bit about your **5** _____?

**G:** Well, I studied engineering at university. I was in the **6** _____ engineering department

**H:** You're head of engineering now. How did you get to where you are today?

**G:** Well, I started in a test lab for airplanes. I did **7** _____ and fatigue tests there. Basically, I broke things! Doing that sort of research is very important as it tells you what **8** _____

the structures can carry. Then I went into airplane design. I worked on all areas of commercial planes before moving into project management in the aircraft industry.

**H:** Could you tell me a bit more about what you do now?

**G:** Sure. These days I mainly work in project management. I take **9** _____ for projects and investigate their **10** _____ – that means I see if the projects are possible. Next, I develop the objectives and estimate the **11** _____ of the project. Then I help the people working on the project to meet their deadlines. I have to make sure projects come in on budget and on **12** _____.

**H:** Now you're head of department and I guess in charge of a lot of people. How do you find that?

**G:** Well, it wasn't too easy at first. I had to prove myself. When they could see that I had good **13** _____ experience and ability, everything was fine.

**H:** I suppose that's true of anyone who's in charge. OK, Lindsey, finally – what's the best thing about being an engineer?

**G:** That's an easy one to answer. I love the **14** _____ of finding **15** _____ to problems. I hope that what I do improves people's lives. For me, engineering is fun, exciting and satisfying.

**H:** Thanks very much, Lindsey. Now, our next guest is someone who ...

### 3.11 Translate into English

1. Инженерное дело – это применение естественных наук и математики, чтобы сделать свойства вещества и источники энергии в природе полезными для людей.
2. Существует множество инженерных дисциплин, каждая из которых имеет свои собственные области и специальности.
3. Инженеры-механики занимаются проектированием и производством изделий и машин.
4. Как и во всех прочих областях инженерного дела, в машиностроении требуется умение решать задачи, что помогает разрабатывать и проектировать некоторые из наиболее важных механизмов, которыми мы все пользуемся.
5. Инженеры-электрики работают над электрическими компонентами, устройствами и системами.
6. Проекты в области электротехники могут включать крошечные детали, такие как микрочипы, или гигантские генераторы для электростанций.
7. Промышленные инженеры используют сочетание научных, математических и инженерных методов для проектирования оборудования, зданий, информационных систем и многого другого.
8. Эти инженеры также помогают управлять бизнесом, определяя, сколько работников необходимо для проекта, сколько времени потребуется для его завершения и какой процесс будет задействован в проекте.
9. Если вы увлекаетесь физикой и микробиологией, химическая технология – это то, что вам нужно.

10. Инженеры-химики используют сочетание инженерных и научных знаний для обработки пищевых продуктов, производства промышленных химикатов и создания фармацевтических препаратов.
11. Строительство – один из старейших видов инженерной деятельности в мире.
12. Инженеры-строители занимаются развитием городской и сельской инфраструктуры от использования водных ресурсов до строительства метро.

**3.12 Answer the following questions**

1. Which engineering discipline are you being trained in?
2. What are the professionals in this discipline concerned with?
3. What kind of knowledge and skills do they need?
4. Where and how are they trained?
5. What personal qualities should they have?
6. Where do they work?
7. Are they in demand on the job market?
8. What are their career prospects?

**3.13 Conservation scientists working on projects in remote regions of the Amazon jungle need volunteers – biologists, chemists, meteorologists, and logisticians who are ready to work in primitive conditions – to join them in environmental projects and scientific research. Listen to the interview with one of the candidates and decide whether the following statements are true (T) or false (F). Correct the wrong statements**

1. The candidate has nine years of work experience.
2. Her present job involves a lot of planning.
3. The candidate has already taken parts in conservation projects.
4. She learned to speak Portuguese while working on one of her previous projects.
5. The candidate worked with a TV crew in the Sahara for four years.
6. She has experience of repairing many different types of machinery.
7. The candidate doesn't mind living in primitive conditions.
8. She is passionate about saving the rainforests and took part in making the documentary *An Inconvenient Truth*.

**3.14 Listen again and make a list of the candidate's strengths and weaknesses. Do you think she will get the job?**

**3.15 Tell about a field of engineering different from the one you are being trained in. Use the questions from Task 3.12 as a plan for your report.**

# Unit 4

# ENGINEERING MATERIALS

## Topical vocabulary

| | |
|---|---|
| 1. engineering material (n) | конструкционный материал |
| 2. metal (n) | металл |
| ferrous (adj) | чёрный (металл) |
| iron (n) | железо |
| cast iron (n) | чугун |
| wrought iron (n) | кованое железо |
| steel (n) | сталь |
| non-ferrous (adj) | цветной (металл) |
| aluminum (n) | алюминий |
| copper (n) | медь |
| nickel (n) | никель |
| titanium (n) | титан |
| zinc (n) | цинк |
| alloy (n) | сплав |
| brass (n) | латунь |
| bronze (n) | бронза |
| 3. polymer (n) | полимер |
| nylon (n) | нейлон |
| polyurethane (n) | полиуретан |
| 4. ceramic (adj) | керамический |
| 5. composite (adj) | композитный (материал) |
| concrete (n) | бетон |
| fiber-glass (n) | стекловолокно |
| plywood (n) | фанера |
| 6. substance (n) | вещество |
| carbon (n) | углерод |
| silicon (n) | кремний |
| paper (n) | бумага |
| stone (n) | камень |
| wood (n) | дерево |
| 7. contain (v) | содержать |
| content (n) | содержание (количество) |
| 8. ratio (n) | соотношение |
| 9. property (n) | свойство |
| ductile (adj) | ковкий, тягучий |
| durable (adj) | долговечный |
| flexible (adj) | гибкий |

| | |
|---|---|
| hard (adj) | твердый |
| inert (adj) | инертный |
| light (adj) | легкий |
| magnet (n) | магнит |
| malleable (adj) | ковкий, податливый |
| melting point (n) | температура плавления |
| soft (adj) | мягкий |
| strong (adj) | прочный |
| tough (adj) | крепкий, прочный |
| weak (adj) | слабый |
| weight (n) | вес |
| 10. conductive (adj) | проводящий |
| electrical conductivity (n) | электропроводность |
| thermal conductivity (n) | теплопроводность |
| semiconductor (n) | полупроводник |
| insulator (n) | изолятор |
| 11. resistance (n) | устойчивость |
| corrosion (n) | коррозия |
| rust (n) | ржавчина |
| wear (n) | износ |
| 12. prevent (v) | предотвратить, не допускать |
| protect (v) | защищать |
| coat (v) | наносить покрытие |
| galvanization (n) | оцинковывание |
| 13. alter (v) | вносить изменения |
| combine (v) | сочетать, комбинировать |
| enhance (v) | повышать, усиливать |
| provide (v) | обеспечивать |
| 14. advantage (n) | преимущество |
| strength (n) | сильная сторона |
| available (adj) | доступный, имеющийся в наличии |
| diverse (adj) | разнообразный |
| excellent (adj) | отличный |
| valuable (adj) | ценный |
| versatile (adj) | многоцелевой, универсальный |
| limitation (n) | ограничение |
| 15. mold (v) | формовать |
| shape (n) | фигура, форма |
| 16. smart (adj) | умный |
| intelligent (adj) | интеллектуальный |
| sense (v) | воспринимать, чувствовать |

| | |
|---|---|
| respond (v) | откликаться, реагировать |
| self-healing (adj) | самовосстанавливающийся |

**4.1 How would you characterize a person who has *a heart of gold*? *nerves of steel*? *the brass neck*? Why?**

**4.2 Read the text and fill in the table**

| **What I knew before reading the text** | **What I learned from the text** | **What made me look at what I knew from a different angle** |
|---|---|---|
| 1. … | 1. … | 1. … |

## ENGINEERING MATERIALS AND THEIR PROPERTIES

Engineering materials are the building blocks of modern society and a critical component of countless products, structures, and machines. From metals and ceramics to polymers and composites, the range of materials available to engineers is vast and constantly evolving. Understanding the properties, strengths, and limitations of each type of material is key to designing and constructing effective and efficient engineering solutions.

Basically, there are mainly three types of engineering materials: metals, polymers, and ceramics

Metals are very common engineering materials. Generally there are three types of metals: ferrous metals, non-ferrous metals, and alloys.

Mainly composed of iron and carbon, ferrous metals are widely used in various industries due to their desirable mechanical properties, availability, and relatively low cost. However, they are prone to rust and corrosion, necessitating protective measures such as coatings, galvanization, or alloying to enhance their resistance to environmental degradation. Common examples of ferrous metals include pure iron (Fe) (a soft and ductile metal), steel (an alloy of iron and carbon), cast iron (an alloy of iron, carbon, and silicon), and wrought iron (a very low-carbon alloy of iron).

Non-ferrous metals are metals that do not contain iron or have very low iron content. These metals are known for their light weight, corrosion resistance, electrical conductivity, and malleability. They find applications in a wide range of industries, including electronics, aerospace, construction, automotive, and more. Some examples of non-ferrous metals include aluminum (Al) (a lightweight metal with excellent corrosion resistance), copper (Cu) (a highly conductive metal with excellent electrical and thermal properties), brass (an alloy of copper and zinc), bronze (an alloy of copper and other elements), nickel (Ni) (a versatile metal with excellent corrosion resistance and high-temperature strength), titanium (Ti) (a lightweight metal with a high strength-to-weight ratio and excellent corrosion

resistance), zinc (Zn) that is commonly used as a protective coating for steel to prevent corrosion.

Alloys are metallic substances that are composed of two or more elements, with at least one of them being a metal. These are created by combining metals or metals and non-metallic elements to enhance their properties or provide new characteristics that are not present in the individual elements. Alloying can alter properties such as strength, hardness, corrosion resistance, electrical conductivity, and melting point. These materials are used in different manufacturing processes such as gear manufacturing, automotive, aerospace applications, and all other manufacturing tasks.

Polymer materials are versatile engineering materials widely used in various industries. They offer flexibility, light weight, corrosion resistance, and electrical insulation. Polymers can be molded into complex shapes, making them suitable for intricate components. However, they may have lower strength compared to metals and temperature limitations. Nevertheless, their advantages make them valuable in applications such as automotive, aerospace, electronics, and packaging. With ongoing advancements, engineers continue to explore and optimize polymer materials to meet evolving design requirements and drive innovation in diverse sectors.

Ceramics are inorganic, nonmetallic materials valued for such useful properties as high strength and hardness, high melting temperatures, chemical inertness, and low thermal and electrical conductivity. In electronic applications they are used as insulators, semiconductors, conductors, and magnets. They also have important uses in the aerospace, biomedical, construction, and nuclear industries.

### 4.3 Mark the following statements T (True), F (False) or N (Not mentioned). Prove your choice with the corresponding lines of the text

1. New engineering materials appear practically every day.
2. The limitations of ferrous metals can’t be overcome.
3. Non-ferrous metals never contain iron.
4. Nickel has found a wide range of applications.
5. Non-ferrous metals and alloys are used in medicine due to their corrosion resistance.
6. Alloys are composed exclusively of metals.
7. Polymers do not conduct electricity.
8. Some polymers can be machined like metals.
9. Metals can withstand a wider range of temperatures than polymers.
10. Ceramics include both organic and inorganic materials.

### 4.4 Find the English equivalents of the following phrases in the text

1. важнейший компонент бесчисленного множества продуктов
2. ассортимент материалов, доступных инженерам
3. состоит в основном из железа и углерода
4. желательные механические свойства

5. подвержен ржавчине и коррозии
6. повышать устойчивость к негативному воздействию окружающей среды
7. находить применение в самых разных отраслях промышленности
8. металл с высокой проводимостью
9. высокая удельная прочность
10. обеспечивать новые характеристики, которых нет у отдельных элементов
11. универсальные конструкционные материалы, широко используемые в различных отраслях промышленности
12. придавать сложную форму
13. обладать меньшей прочностью по сравнению с металлами
14. стимулировать инновации в различных отраслях
15. низкая тепло- и электропроводность

**4.5 Find words in the text whose meaning is similar to the meaning of the following words**

1. selection
2. diverse
3. to intensify
4. universal
5. proportion
6. to avoid
7. to offer
8. to modify
9. to shape
10. to research

**4.6 Find words in the text whose meaning is opposite to the meaning of the following words**

1. weakness
2. evolution
3. alloyed
4. hard
5. heavy
6. poor
7. wrong
8. reactivity

**4.7 a) Match the adjectives / nouns and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Adjective / Noun | Noun |
|---|---|
| 1. building | a) advancements |
| 2. ferrous | b) blocks |
| 3. desirable | c) conductivity |
| 4. environmental | d) coating |
| 5. corrosion | e) degradation |
| 6. protective | f) insulation |
| 7. melting | g) inertness |
| 8. versatile | h) metals |
| 9. electrical | i) materials |
| 10. complex | j) properties |
| 11. ongoing | k) point |
| 12. high | l) resistance |
| 13. diverse | m) strength |
| 14. chemical | n) shapes |

| | |
|---|---|
| 15. thermal | o) sectors |

**b) Match the verbs and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Verb | Noun |
|---|---|
| 1. to enhance | a) applications |
| 2. to drive | b) corrosion |
| 3. to find | c) innovation |
| 4. to prevent | d) properties |
| 5. to alter | e) requirements |
| 6. to meet | f) resistance |

**4.8 Find the corresponding prepositions for the following verbs and phrases in the text. Make sentences of your own where the verbs and phrases are used in combination with the prepositions**

1. to be key _____
2. to be composed _____
3. to be prone _____
4. to be known _____
5. to be created _____
6. to be molded _____
7. to be suitable _____

**4.9 Match the properties of engineering materials and their descriptions**

| Property | Description |
|---|---|
| 1. chemical inertness | a) temperature at which a solid material transforms into a liquid state |
| 2. corrosion resistance | b) resistance of a material to scratching, cutting, indentation or abrasion |
| 3. ductility | c) resistance of a material to breaking under repeated twisting and bending forces |
| 4. flexibility | d) quality of being unreactive with other chemical compounds or elements |
| 5. hardness | e) capability of being shaped or extended by hammering, forging, pressing between rollers, etc. |
| 6. malleability | f) ability of a material to withstand erosion or degradation due to contact with other surfaces |
| 7. melting point | g) ability of a material to withstand an applied force without breaking or deforming |
| 8. strength | h) ability of a material to withstand chemical reactions with its surroundings |

| | |
|---|---|
| 9. toughness | i) ability of a material to have its shape changed (as by being drawn out into wire or thread) without losing strength or breaking |
| 10. wear resistance | j) ability of a material to bend or be bent repeatedly without breaking |

**4.10 Complete the conversation about sports equipment with words from the list below. Try to summarize the content of the conversation in 45 words or less**

**fibre-glass flexible hard hardness light (x2) nylon polyurethane steel strength (x2) strong tough wear-resistant wood**

**A** OK, so tell me about the skateboard.
**B** Right. The body part is the deck.
**A** What's it made of?
**B** Plywood. This means it's **1** _____ and **2** _____.
**A** OK. What's the difference between the front and back?
**B** The front is called the nose. And the back is the tail.
**A** Nose and tail. Right.
B There's an angle of twenty degrees.
**A** What for?
**B** It helps the skateboarder perform tricks.
**A** Cool. So, what about under the board?
**B** These things are the trucks.
**A** What are they made of? Metal?
**B** Yes – sometimes it's titanium for **3** _____. The top is called the baseplate. The bottom is the hanger.
**A** Got it. And the wheels – they're plastic, right?
**B** Right. They're made of **4** _____. The **5** _____ varies. Very **6** _____ wheels are good for performance. Is that it?
**A** What about these? Are they springs, like a car suspension?
**B** Oh yes, they're called bushings. They help you to turn the board. …
**B** ... I think I know a bit about the snowboard. Is it made of **7** _____?
**A** Yeah, partly. But **8** _____ is used for the core.
**B** Really? How come?
**A** It gives the board **9** _____ but keeps it **10** _____. And it makes it **11** _____.
**B** OK. Is it the same on both sides?
**A** The base, the bottom, is covered with a kind of **12** _____ plastic.
**B** What's it called?
**A** *P-tex*. It helps the board slide but it's **13** _____.
**B** Right. Important on snow. What about the edge? Is it made of *p-tex* as well?
**A** No, that's **14** _____. It helps the board grip the snow.
**B** When it turns and does tricks?

**A** Yeah, I suppose so.
**B** OK. Oh, and these straps – are they made of **15** _____?
**A** Yeah. They're called bindings. That's it.

### 4.11 Translate into English

1. Передовые инженерные материалы играют решающую роль в современных технологиях и инновациях.
2. Эти материалы специально оптимизированы для обеспечения определенных эксплуатационных характеристик, таких как повышенная прочность, гибкость и устойчивость к коррозии.
3. Передовые инженерные материалы доступны в различных формах, включая металлы, керамику, полимеры и композиты.
4. Эти материалы могут быть сложным образом структурированы на атомном и молекулярном уровнях для получения уникальных и очень востребованных свойств.
5. Одним из самых привлекательных аспектов передовых инженерных материалов является возможность создавать более компактные, легкие и эффективные изделия с улучшенными эксплуатационными характеристиками и повышенной долговечностью.
6. Композитные материалы – пример передовых инженерных материалов, обладающих улучшенными свойствами по сравнению с традиционными материалами.
7. Такие материалы изготавливаются из двух или более составляющих с существенно отличающимися физическими или химическими свойствами. В результате получается материал с характеристиками, отличными от характеристик отдельных компонентов.
8. Интеллектуальные материалы, также известные как «умные» или «адаптивные» материалы, являются еще одной областью, где ведутся важные разработки.
9. Эти материалы могут реагировать на изменения в окружающей среде, такие как изменение температуры, уровня освещенности или механическое напряжение, претерпевая обратимые изменения в своих свойствах.
10. «Умные» материалы используются повсеместно — от самовосстанавливающихся материалов в аэрокосмической отрасли до сплавов с памятью формы в биомедицинских устройствах.

### 4.12 Select an object you use in your everyday life. Think of the material / materials it is made of. Answer the following questions

1. Which materials have been used for making such objects throughout history?
2. What are the advantages and disadvantages of each material?
3. Are there any rare objects of this kind made of some specific material? Why is this particular material used? Why aren’t all the objects made of it?

4. What other materials might be used for this purpose in the future? Why?

**4.13 Answer the following questions**

1. Which materials are usually used for building bridges?
2. What properties are important for such materials?

**Listen to the text 'Experimental Bridge' and complete your answers if there is any new information in the text. Answer the following questions**

3. Why is the bridge experimental?
4. What are the advantages and disadvantages of this experimental bridge?
5. Do you think such bridges could find real-life applications?

**4.14 Listen again. What do the following numbers refer to?**

| | | | |
|---|---|---|---|
| 1. 32 ft | 3. 10 ft | 5. 2 months | 7. 72,000 lb |
| 2. 80 ft | 4. 4 ft | 6. 12,000 lb | 8. 9,000 lb |

**4.15 Design a project where a widespread material is used unusually. Describe the advantages and disadvantages of using this material for the purpose and analyze the feasibility of such a project as a whole.**

# Unit 5

# NANOTECHNOLOGY

## Topical vocabulary

| | |
|---|---|
| 1. measure (v) | измерять; иметь размер |
| unit of measure (n) | единица измерения |
| scale (n) | масштаб |
| huge (adj) | огромный |
| tiny (adj) | крошечный |
| 2. reduce (v) | уменьшать, сокращать |
| 3. dimension (n) | измерение, размерность |
| two-dimensional (adj) | двумерный |
| 4. visible light (n) | видимый свет |
| light microscope (n) | световой микроскоп |
| wavelength (n) | длина волны |
| 5. bulk material (n) | макроматериал, объёмный материал |
| 6. chemical composition (n) | химический состав |
| 7. surface (n) | поверхность |
| surface area (n) | площадь поверхности |
| volume (n) | объём |
| 8. cluster (n) | скопление, кластер |
| film (n) | плёнка |
| particle (n) | частица |
| wire (n) | провод |
| 9. behave (v) | вести себя |
| phenomenon (n) | явление |
| 10. classical physics (n) | классическая физика |
| common sense (n) | здравый смысл |
| 11. quantum mechanics (n) | квантовая механика |
| contradict (v) | противоречить |
| electron tunneling (n) | туннелирование электронов |
| erratically (adv) | хаотично |
| penetrate (v) | проникать |
| teleport (v) | телепортироваться |
| 12. electric charge (n) | электрический заряд |
| capacity (n) | ёмкость |
| 13. antimicrobial (adj) | противомикробный |
| biocompatible (adj) | биосовместимый |
| transparent (adj) | прозрачный |
| 14. cell (n) | клетка |
| 15. reproduce (v) | воспроизводить |

self-replicating (adj) самовоспроизводящийся

**5.1 Read the quote and explain how you understand it in terms of technology**

“There's plenty of room at the bottom.” (Richard Feynman)

**5.2 Read the text and fill in the table**

| **What I knew before reading the text** | **What I learned from the text** | **What made me look at what I knew from a different angle** |
|---|---|---|
| 1. … | 1. … | 1. … |

## THE WORLD OF NANOTECHNOLOGY

There's an unprecedented multidisciplinary convergence of scientists dedicated to the study of a world so small, we can't see it – even with a light microscope. That world is the field of nanotechnology, the realm of atoms and nanostructures. Nanotechnology is so new, no one is really sure what will come of it. Even so, predictions range from the ability to reproduce things like diamonds and food to the world being devoured by self-replicating nanorobots.

In order to understand the unusual world of nanotechnology, we need to get an idea of the units of measure involved. A centimeter is one-hundredth of a meter, a millimeter is one-thousandth of a meter, and a micrometer is one-millionth of a meter, but all of these are still huge compared to the nanoscale. A nanometer (nm) is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the width of a human hair.

Experts sometimes disagree about what constitutes the nanoscale, but in general, you can think of nanotechnology dealing with anything measuring between 1 and 100 nm. Larger than that is the microscale, and smaller than that is the atomic scale.

One of the exciting and challenging aspects of the nanoscale is the role that quantum mechanics plays in it. The rules of quantum mechanics are very different from classical physics, which means that the behavior of substances at the nanoscale can sometimes contradict common sense by behaving erratically. You can't walk up to a wall and immediately teleport to the other side of it, but at the nanoscale an electron can – it's called electron tunneling. Substances that are insulators, meaning they can't carry an electric charge, in bulk form might become semiconductors when reduced to the nanoscale. Melting points can change due to an increase in surface area. Much of nanoscience requires that you forget what you know and start learning all over again.

So what does this all mean? Right now, it means that scientists are experimenting with substances at the nanoscale to learn about their properties and how we might be able to take advantage of them in various applications. Engineers are trying to use nano-size wires to create smaller, more powerful microprocessors. Doctors are searching for ways to use

nanoparticles in medical applications. Still, we've got a long way to go before nanotechnology dominates the technology and medical markets.

### 5.3 Answer the following questions

1. Why can't nanoscale objects be seen with a light microscope?
2. How big / small is nanoscale? Put the following things in order of their size from the smallest to the biggest: *an atom, a human hair, a nanometer, wavelength of visible light*.
3. Why can insulators in bulk form become semiconductors at the nanoscale?
4. Why do melting points change at the nanoscale?
5. What are current applications of nanotechnology? Give examples both from the text and your own.
6. What predictions are made about the future of nanotechnology? Which of them seem more accurate to you?

### 5.4 Find the English equivalents of the following phrases in the text

1. беспрецедентное объединение усилий ученых, представляющих разные области знаний
2. мир атомов и наноструктур
3. способность воспроизводить, к примеру, алмазы и продукты питания
4. быть поглощенным самовоспроизводящимися нанороботами
5. получить представление о применяемых единицах измерения
6. меньше длины волны видимого света
7. стотысячная часть толщины человеческого волоса
8. вести себя неустойчиво
9. переносить электрический заряд
10. увеличить площадь поверхности
11. искать способы применения наночастиц в медицине
12. впереди долгий путь

### 5.5 Find words in the text whose meaning is similar to the meaning of the following words

1. extraordinary
2. consolidation
3. focused
4. area
5. to destroy
6. to reproduce
7. to make
8. size
9. side
10. traditional
11. material
12. to oppose
13. to act
14. to transfer
15. to look

**5.6 Find words in the text whose meaning is opposite to the meaning of the following words**

1. tiny
2. boring
3. easy
4. similar
5. systematically
6. later
7. to enlarge
8. to remember

**5.7 a) Match the adjectives / nouns and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Adjective / Noun | Noun |
|---|---|
| 1. multidisciplinary | a) area |
| 2. self-replicating | b) charge |
| 3. visible | c) convergence |
| 4. human | d) form |
| 5. atomic | e) hair |
| 6. quantum | f) light |
| 7. classical | g) mechanics |
| 8. common | h) nanorobots |
| 9. electron | i) physics |
| 10. electric | j) scale |
| 11. bulk | k) sense |
| 12. surface | l) tunneling |

**b) Match the verbs and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Verb | Noun |
|---|---|
| 1. to reproduce | a) advantage |
| 2. to devour | b) common sense |
| 3. to contradict | c) an electric charge |
| 4. to carry | d) diamonds |
| 5. to take | e) markets |
| 6. to dominate | f) the world |

**5.8 Find the corresponding prepositions for the following verbs and phrases in the text. Make sentences of your own where the verbs and phrases are used in combination with the prepositions**

1. to be dedicated _____
2. to come _____
3. to range _____ ... _____
4. to disagree _____
6. to be reduced _____
7. to experiment _____
8. to take advantage _____
9. to search _____

5. to deal _____

**5.9 Match the words and their definitions**

| Word | Definition |
|---|---|
| 1. biocompatible | a) allowing light to pass through so that objects on the other side can be clearly seen |
| 2. bulk | b) the smallest basic unit of a living organism |
| 3. capacity | c) to be a particular size |
| 4. cell | d) to travel, often instantaneously, from one point to another without physically crossing the distance between the two points |
| 5. cluster | e) having no harmful effect on living organisms |
| 6. film | f) a small group of similar things that are closely packed together |
| 7. to measure | g) large in size, mass or volume |
| 8. particle | h) a thin layer of something on a surface |
| 9. teleport | i) an extremely small piece of something |
| 10. transparent | j) a measure of the electric output of a battery or generator |

**5.10 Complete the text with words from the list below. Try to summarize the content of the text in 35 words or less**

**capacity cell clothes conductive electronics faster glucose ordinary (x2) possibilities (x2) sports stronger (x2) tiny thinner touchscreen (x2) transparent vaccines**

Nanotechnology is this new field of science and engineering that you're going to see everywhere. You may not realize it, but nanotechnology is already changing the game. It's given us **1** _____ computers and **2** _____ building materials, not to mention every **3** _____ you've ever used.

The key is the discovery of new, **4** _____ materials. Take a look at the objects around you, the **5** _____ you love, the **6** _____ equipment you use, the **7** _____ you wear.

Think about the materials they're made of. It might seem incredible, but we can make something revolutionary from something that seems **8** _____.

When regular materials are made very small, they can become **9** _____, brighter, even biocompatible. For example, when it comes to **10** _____ technology, we take a regular piece of glass and coat it with a **11** _____ film that's hundreds of times **12** _____ than the foil in your kitchen.

That kind of technology can even turn **13** _____ windows into **14** _____ solar panels.

When you combine this new technology with the unlimited creativity of humanity, the **15** _____ are endless. We're going to see ultra-**16** _____ batteries that can power trucks, trains, and even airplanes; drinking water that can be harvested from the humidity in the air;

**17** _____ levels that can be monitored continuously and painlessly. Plus, all sorts of **18** _____ and gene therapies that can be delivered directly inside the **19** _____.

Nanotechnology is opening up a whole new universe of **20** _____ where our imagination is the limit.

### 5.11 Translate into English

1. Свойства элементов, с которыми мы знакомы по нашему повседневному опыту, могут не проявляться на наноуровне.
2. Например, уменьшая объем золота до размера наночастиц, вы снижаете его температуру плавления, потому что, когда вы уменьшаете любую частицу до наноразмеров, отношение поверхности к объему значительно увеличивается.
3. Кроме того, на наноуровне золото ведет себя как полупроводник, а в обычном состоянии оно проводит электричество.
4. В своём обычном состоянии алюминий не обладает магнитными свойствами, но очень маленькие скопления атомов алюминия могут их проявлять.
5. Некоторые элементы, например кремний, практически не меняются на наноуровне, что делает их идеальными для транзисторов и других применений.
6. При работе с объектами, размеры которых сопоставимы с размерами наночастиц или меньше, мы сталкиваемся с областью квантовой механики, которая часто противоречит законам классической физики.
7. Обычно электрон не может пройти через изолятор, но если изолятор достаточно тонкий, то электрон может переместиться с одной стороны изолятора на другую.
8. Это явление называется туннелированием электронов, однако название на самом деле не дает вам представления о том, насколько необычным может быть этот процесс.
9. Электрон перемещается с одной стороны изолятора на другую, фактически не проникая в сам изолятор и не занимая пространство внутри него.
10. Можно сказать, что он телепортируется с одной стороны на другую.

### 5.12 Think of the engineering discipline you are being trained in and answer the following questions

1. Is nanotechnology already part of the area? If yes, how is it used?
2. If nanotechnology is not used in the area now, does it have any prospects in it? What are they?
3. What are the possible benefits and threats of using nanotechnology in the area?
4. What might the distant future of the area be like if nanotechnology and its methods keep developing?

**5.13 Listen to information about nanotechnology and decide whether the following statements are true (T) or false (F). Correct the wrong statements**

1. The chemical composition of nanomaterials is radically different from the chemical composition of bulk materials.
2. Nanoparticles are composed of 100 atoms or less.
3. The behavior of nanomaterials is determined by their shape and size.
4. All nanomaterials sink in solutions because of their small size.
5. Nanomaterials may differ in color from their bulk counterparts.
6. Scientists can manipulate nanomaterials so that they meet specific requirements.
7. Bulk silver has antimicrobial properties.
8. Some nanostructures made of silver are transparent.

**5.14 Listen again and fill in the table. Add your own ideas**

| Nanomaterial | Properties | Uses |
|---|---|---|
| 1. … | 1. … | 1. … |

**5.15 Tell about a nanoobject (you can find examples of such objects and their short descriptions in the *Appendix*). While preparing your report answer the following questions**

1. What is the structure of the object?
2. How can such an object be obtained?
3. What are the properties of the object?
4. How may such an object be used?
5. What are the advantages and disadvantages of the object?
6. What are the future prospects of the object?

# Unit 6

# ROBOTICS

## Topical vocabulary

| | |
|---|---|
| 1. robot (n) | робот |
| robotic arm (n) | робот-манипулятор |
| drone (n) | беспилотный летательный аппарат |
| exoskeleton (n) | экзоскелет |
| humanoid (adj) | человекоподобный |
| prosthetic limb (n) | протез конечности |
| rover (n) | планетоход |
| submarine (n) | подводная лодка |
| 2. task (n) | задача |
| boring (adj) | скучный |
| dangerous (adj) | опасный |
| monotonous (adj) | монотонный |
| repetitive (adj) | повторяющийся |
| 3. carry out (v) | выполнять |
| accomplish (v) | осуществлять, совершать |
| handle (v) | обращаться, работать (с чем-либо) |
| perform (v) | исполнять, делать |
| 4. actuator (n) | привод, управляющее устройство |
| drive (v) | приводить в движение |
| hydraulic (adj) | гидравлический |
| fluid (n) | жидкость |
| pump (n) | насос |
| pneumatic (adj) | пневматический |
| compress (v) | сжимать |
| valve (n) | клапан |
| 5. circuit (n) | (электрическая) схема, цепь |
| 6. end effector (n) | рабочий орган |
| outfit (v) | оснащать, оборудовать |
| arc-welder (n) | аппарат для дуговой сварки |
| blowtorch (n) | паяльная горелка |
| drill (n) | сверло |
| gripper (n) | захват, зажим, клещи |
| spray painter (n) | распылитель краски |
| 7. move (v) | передвигать |
| carry (v) | переносить, перемещать |
| grasp (v) | удерживать |
| manipulate (v) | манипулировать |

| | |
|---|---|
| pivot (v) | поворачивать |
| spin (v) | вращать |
| 8. assemble (v) | собирать |
| assembly line (n) | сборочный конвейер |
| tighten (v) | завинчивать, затягивать |
| plaster (v) | штукатурить |
| weld (v) | сваривать |
| 9. sensor (n) | датчик |
| 10. adapt (v) | адаптироваться |
| autonomous (adj) | автономный, независимый |
| teleoperated (adj) | управляемый дистанционно |
| 11. locomotion (n) | передвижение |
| joint (n) | сустав, сочленение |
| leg (n) | нога |
| snake (n) | змея |
| track (n) | гусеница, трак |
| tread (n) | звено гусеницы |
| wheel (n) | колесо |
| 12. terrain (n) | местность, ландшафт, рельеф |
| confined (adj) | ограниченный, замкнутый, изолированный |
| rough (adj) | шершавый, неровный |
| smooth (adj) | гладкий |
| 13. aerial (adj) | воздушный, летающий |
| hover (v) | зависать в воздухе |
| 14. construction (n) | строительство |
| exploration (n) | изучение |
| inspection (n) | осмотр |
| research (n) | исследование |
| surgery (n) | хирургия |
| surveillance (n) | наблюдение, слежение |
| 15. assist (v) | содействовать, помогать |
| augment (v) | приумножать, наращивать, дополнять |
| mimic (v) | копировать, имитировать |
| swarm (v) | роиться, собираться в стаи |
| 16. accurate (adj) | верный, безошибочный |
| delicate (adj) | тонкий, сложный |
| precise (adj) | точный |

### 6.1 Read the quote and comment on it

“Man is a robot with defects.” (*Emile M. Cioran*)

**6.2 Read the text and fill in the table**

| **What I knew before reading the text** | **What I learned from the text** | **What made me look at what I knew from a different angle** |
|---|---|---|
| 1. … | 1. … | 1. … |

## ROBOTS AT WORK

The term *robot* comes from the Czech word *robota*, generally translated as "forced labor." This describes the majority of robots fairly well. Most robots in the world are designed for heavy, repetitive manufacturing work. They handle tasks that are difficult, dangerous or boring to human beings.

For example, the robotic arm is frequently used in manufacturing roles. Its job is to move an end effector from place to place. You can outfit robotic arms with all sorts of end effectors, which are suited to a particular application. One common end effector is a simplified version of the hand, which can grasp and carry different objects. Other end effectors include blowtorches, drills and spray painters.

Most industrial robots work in auto assembly lines, putting cars together. Robots can do a lot of this work more efficiently than human beings because they are so precise. They always drill in the same place, and they always tighten bolts with the same amount of force, no matter how many hours they've been working. Manufacturing robots are also very important in the computer industry. It takes an incredibly precise hand to put together a tiny microchip.

You may find robots working alongside construction workers, plastering walls accurately and faster than a human can do the job. Robots assist in underwater exploration. Surgeons use robots to handle delicate surgeries. They even handle flipping burgers in the kitchen. These robots all have a form of robotic arm.

Robotic arms are relatively easy to build and program because they only operate within a confined area. Things get a bit trickier when you send a robot out into the world.

First, the robot needs a working locomotion system. If the robot only needs to move over smooth ground, wheels are often the best option. Wheels and tracks can also work on rougher terrain. But robot designers often look to legs instead, because they are more adaptable. Building legged robots also helps researchers understand natural locomotion – it's a useful exercise in biological research.

Designers commonly look to the animal world for robotic locomotion ideas. Six-legged insects have exceptionally good balance, and they adapt well to a wide variety of terrain. Four-legged robots such as Boston Dynamics' Spot look like dogs, and the similarity breeds comparisons as they take on dangerous jobs such as construction inspection.

Aerial robots are also inspired by real-world examples. Although many use wings like we see on airplanes, researchers have also developed techniques using fly-wing-like soft

actuators. Most people now are familiar with the propeller-powered drones that provide amazing camera shots for entertainment, sporting events and surveillance. Some of these hovering bots can also be networked together to create swarms of robots such as those seen at the Tokyo Summer Olympic Games in 2021.

Underwater, robots may walk across the sea floor. One example is Silver 2, a crab-like robot designed to find and clean up plastic waste. The Benthic Rover II uses treads instead. Snake robots, which of course take their name from the animals whose locomotion they copy, can operate underwater and on land. They even work well in the human body, where they can perform surgical repairs.

**6.3 Choose the correct option. Prove your choice with the corresponding lines of the text**

1. The origin of the word ***robot*** suggests that robots
   a) can work better than humans.
   b) can only work and do not have feelings.
   c) are mechanical.
   d) are designed to do work that humans can't or don't want to do.
2. The robotic arm
   a) cannot be reprogrammed for performing different tasks.
   b) can perform a variety of operations depending on its end effector.
   c) has capabilities exceeding those of a human hand.
   d) is the exact copy of the human hand.
3. Manufacturing robots are very important in the computer industry because
   a) they are precise.
   b) they are smaller than humans.
   c) they always apply the same amount of force.
   d) they don't get tired.
4. What do construction, medical, and kitchen robots have in common?
   a) They all are faster than humans.
   b) They all are more accurate than humans.
   c) They all have the same shape.
   d) They all work alongside humans.
5. Why do designers develop robots with legs?
   a) Because wheels and tracks do not work on rough terrain.
   b) Because people always want to solve more difficult problems.
   c) Because legs do less harm to natural environments than wheels or tracks.
   d) Because a legged robot is more versatile.
6. What number of legs is the best option for a robot designed to work in a variety of terrain?
   a) two b) four c) six d) eight

7. Which of the following are propeller-powered drones **not** capable of?
   a) flapping their wings
   b) hovering
   c) swarming
   d) taking photos
8. Silver2 underwater robot
   a) moves on tracks
   b) moves on legs
   c) moves like a snake
   d) is a robotic arm

### 6.4 Find the English equivalents of the following phrases in the text

1. происходить от чешского слова
2. выполнять сложные, опасные или неинтересные для человека задачи
3. подходить для конкретного применения
4. упрощенный вариант руки
5. сверлить в одном и том же месте
6. затягивать болты с одинаковым усилием
7. относительно просто собрать и запрограммировать
8. работать в ограниченном пространстве
9. обратиться к миру животных в поисках идей для передвижения роботов
10. обладать исключительным равновесием
11. хорошо адаптироваться к самым разным ландшафтам
12. браться за опасную работу
13. беспилотные летательные аппараты с винтовым двигателем
14. объединяться в сеть для формирования роя роботов
15. работать под водой и на суше

### 6.5 Find words in the text whose meaning is similar to the meaning of the following words

| | | | | |
|---|---|---|---|---|
| 1. work | 4. accurate | 7. skillful | 10. to motivate | 13. to hang |
| 2. to manage | 5. quantity | 8. limited | 11. method | 14. crowd |
| 3. to equip | 6. to help | 9. to conform | 12. observation | 15. to execute |

### 6.6 Find words in the text whose meaning is opposite to the meaning of the following words

| | | | | |
|---|---|---|---|---|
| 1. voluntary | 3. exciting | 5. complicated | 7. to loosen | 9. fictional |
| 2. safe | 4. seldom | 6. to release | 8. rough | 10. ignorant |

**6.7 a) Match the adjectives / nouns and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Adjective / Noun | Noun |
|---|---|
| 1. forced | a) area |
| 2. repetitive | b) event |
| 3. end | c) exploration |
| 4. spray | d) example |
| 5. assembly | e) effector |
| 6. underwater | f) floor |
| 7. delicate | g) job |
| 8. confined | h) locomotion |
| 9. natural | i) line |
| 10. animal | j) labor |
| 11. dangerous | k) painter |
| 12. real-world | l) surgeries |
| 13. sporting | m) world |
| 14. sea | n) work |

**b) Match the verbs and the nouns to form all possible word combinations. Make sentences of your own with the word combinations**

| Verb | Noun |
|---|---|
| 1. to handle | a) bolts |
| 2. to grasp | b) camera shots |
| 3. to tighten | c) objects |
| 4. to plaster | d) surgical repairs |
| 5. to provide | e) tasks |
| 6. to perform | f) walls |

**6.8 Find the corresponding prepositions for the following verbs and phrases in the text. Make sentences of your own where the verbs and phrases are used in combination with the prepositions**

1. to be used _____
2. to outfit something _____
3. to be suited _____
4. to put something _____
5. to assist _____
6. to move _____
7. to look _____
8. to adapt _____
9. to be inspired _____
10. to be familiar _____
11. to walk _____

**6.9 Match the words and their definitions**

| Word | Definition |
|---|---|
| 1. actuator | a) to turn round and round rapidly, or make something turn round and round rapidly |
| 2. assembly line | b) to turn or twist |
| 3. to augment | c) a substance (such as a liquid or gas) tending to flow or conform to the outline of its container |
| 4. autonomous | d) the place where parts or pieces of something are joined together |
| 5. drone | e) to increase the size or value of something by adding something to it |
| 6. end effector | f) to imitate closely |
| 7. fluid | g) ground or a piece of land seen in terms of its surface features or general physical character |
| 8. joint | h) a mechanical device for moving or controlling something |
| 9. to mimic | i) a device that responds to a physical stimulus (such as heat, light, sound, pressure, magnetism, or a particular motion) and transmits a resulting impulse (as for measurement or operating a control) |
| 10. to pivot | j) a device that controls the flow of gas or liquid from one place to another |
| 11. sensor | k) any attachment on the end of a robot that interacts with the environment, such as a tool to manipulate objects |
| 12. to spin | l) an arrangement of machines, equipment, and workers in which work passes from operation to operation in direct line until the product is assembled |
| 13. terrain | m) an aircraft operated by remote control or onboard computers, especially an unmanned aerial vehicle (UAV) |
| 14. valve | n) able to operate without being controlled directly by humans |

**6.10 Complete the text with words from the list below. Try to summarize the content of the text in 40 words or less**

**batteries bodies bones camera computer (x2) electrical fluid joints motors (x2) movement pivot pneumatic (x2) power (x2) reprogrammable sensory spin**

Most robots have movable **1 _____.** Some only have motorized wheels, and others have dozens of movable segments, typically made of metal or plastic. Like the **2** _____ in your body, the individual segments are connected together with **3** _____.

Robots **4** _____ wheels and **5** _____ jointed segments with some sort of actuator. Some robots use electric **6** _____ and solenoids as actuators; some use a hydraulic system; and some use a **7** _____ system (a system driven by compressed gases). Robots may use a combination of all these actuator types.

A robot needs a **8** _____ source to drive these actuators. Most robots either have **9** _____ or plug into the wall. Some may use solar **10** _____ or fuel cells. Hydraulic robots also need a pump to pressurize the hydraulic **11** _____, and **12** _____ robots need an air compressor or compressed-air tanks.

The actuators are all wired to **13** _____ circuits. The robot's **14** _____ controls everything attached to the circuits. To move the robot, the **15** _____ switches on all the necessary **16** _____ and valves. Many robots are **17** _____ – to change the robot's behavior, you update or change the software that gives the robot its instructions.

Not all robots have **18** _____ systems, and few can see, hear, smell or taste. The most common robotic sense is the sense of **19** _____ – the robot's ability to monitor its own motion. One way to do this is to use a laser on the bottom of the robot to illuminate the floor while a **20** _____ measures the distance and speed traveled.

**6.11 Translate into English**

1. Робот – это управляемая компьютером машина, запрограммированная на перемещение объектов, манипулирование ими и выполнение работы во взаимодействии с окружающей средой.
2. Роботы способны выполнять повторяющиеся задачи быстрее, точнее и с меньшими затратами, чем люди.
3. Термин «робот» происходит от чешского слова «robota», означающего «принудительный труд». Он был впервые использован в пьесе «R.U.R. (Rossum's Universal Robots – Универсальные роботы Россума)», написанной в 1921 году чешским писателем и драматургом Карелом Чапеком.
4. С тех пор слово «робот» используется для обозначения машины, которая выполняет работу по оказанию помощи людям или работу, которую люди считают трудной или нежелательной.
5. Создание состоящей из множества звеньев искусственной руки, или манипулятора, привело к появлению современного робота.

6. Многие роботы оснащены специальными захватами или рабочими органами, имитирующими функции и строение человеческой руки.
7. С помощью таких захватов роботы могут удерживать различные устройства, например, подставку с пробирками или аппарат для дуговой сварки.
8. Роботы широко используются в промышленности и частично заменили человеческий труд.
9. В автомобильной промышленности роботы используются для выполнения различных операций на конвейере: они сверлят отверстия одинакового размера точно в одних и тех же местах, затягивают болты в соответствии с конструктивными особенностями автомобиля и выполняют множество других производственных операций.
10. Роботы применяются хирургами для установки искусственных суставов, а высокоточные роботы могут ассистировать при проведении сложных операций на глазах.
11. Автономные роботы способны анализировать незнакомые условия и приспосабливаться к ним, даже на пересечённой местности.
12. Робот-планетоход, например, может составить карту местности перед собой на основе информации, полученной от оптических датчиков.

## 6.12 Think of the engineering discipline you are being trained in and answer the following questions

1. Are robots already part of the area? If yes, how are they used?
2. If robots are not used in the area now, do they have any prospects in it? What kind of prospects do they have?
3. What are the possible advantages and disadvantages of using robots in the area?
4. How may using robots affect the area in the future?

## 6.13 Listen to the information about different types of robots and put these examples of robots into the appropriate group

**Atlas drones exoskeletons mechanical arm prosthetic limbs Roomba Sophia submarines**

1. pre-programmed robots
2. humanoid robots
3. autonomous robots
4. tele-operated robots
5. augmenting robots

**6.14 Listen again and fill in the table**

| Type of robot | Functions | Capabilities |
|---|---|---|
| 1. pre-programmed robots | | |
| 2. humanoid robots | | |
| 3. autonomous robots | | |
| 4. tele-operated robots | | |
| 5. augmenting robots | | |

**6.15 Design a robot you would like to exist. When telling about it, answer the following questions**

1. What tasks will the robot handle?
2. Which type of robot will it be?
3. What parts will it consist of? How will they work? How will they be powered?
4. What materials will be used to build it?
5. Will it be possible to introduce such robots on a wide scale? If so, how will they affect people's lives? If not, why?
6. What do you think of the feasibility of your project as a whole?

# APPENDIX

## Nano This and Nano That

**Nanocrystals:** Nanoscale crystals that are often harder, stronger and more wear resistant than the same materials in bulk form. Nanocrystals might be used to make super-strong and long-lasting metal parts. The crystals also might be added to plastics and other metals to make new types of composite structures for everything from cars to electronics. Single atoms caged inside nanocrystals gives you a "quantum confined atom", or QCA, with potential uses ranging from clear-glass sunglasses to bio-sensors to optical computing and just about anything optical in between.

**Nanoshells:** Nanoscale metal spheres, which can absorb or scatter light at virtually any wavelength. Metal nanoshells may be embedded in solid-state materials and films, such as plastics or glasses, or attached directly to surfaces for special-purpose coatings. New products could include energy efficient paints and windows, coatings for cars, airplanes or buildings, solar collection materials, or even fabrics. Their ability to absorb light is so great that if you put just one thousandth of an ounce of nanoshells into a quart of water, the water would be completely opaque.

**Nanohorns:** One of the SWNT (single walled carbon nanotube) types, with an irregular horn-like shape, which may be a critical component of a new generation of fuel cells. The main characteristic of the carbon nanohorns is that when many of the nanohorns group together an aggregate (a secondary particle) of about 100 nanometers is created. The advantage being, that when used as an electrode for a fuel cell, not only is the surface area extremely large, but also, it is easy for the gas and liquid to permeate to the inside. In addition, compared with normal nanotubes, because the nanohorns are easily prepared with high purity it is expected to become a low-cost raw material.

**Nanowires:** Semiconductor nanowires are one-dimensional structures, with unique electrical and optical properties, that are used as building blocks in nanoscale devices. Striped or 'superlatticed' nanowires can function as transistors, LEDs (light-emitting diodes) and other optoelectronic devices, biochemical sensors, heat-pumping thermoelectric devices, or all of the above, along the same length of wire.

**Nanosprings:** A nanowire wrapped into a helix. Speculation is that they may someday make highly sensitive magnetic field detectors, perhaps finding application in hard drive read heads. Alternatively, nanosprings could serve as positioners, or even as tiny conventional springs, for nanomachines of the future.

**Nanomesh and Nanofibres**: Currently used in air and liquid filtration applications. Using a process called "electrospinning" – or e-spin – a polymer "mesh" is formed into a nanofiber membrane, hense "nanomesh", with 150 – 200 nm diameters. Some have been made since

1970, but were not called "nano" until recently. One potential use is to prevent body tissues from sticking together as they heal. It also breaks down in the body over time like biodegradable sutures, which makes it a surgical material for the 21st century. Other uses include biomedical devices, filtration systems, and dust collecting systems.

**Nanofilters:** One opportunity for nanoscale filters is for the separation of molecules, such as proteins or DNA, for research in genomics. Another, as masks to prevent exposure to biological pathogens such as viruses that can be as small as 30 nanometers in diameter. And another use is in water filtration.

**Nanobalance:** Simply put, a nanoscale balance for determining mass, small enough to weigh viruses and other sub-micron scale particles. A mass attached at the end of a nanotube shifts its resonance frequency. If the nanotube is calibrated (i.e., its spring constant known), it is possible to measure the mass of the attached particle. A nanobalance could be useful for determining the mass of other objects on the femtogram to picogram size range.

**Nanopores:** Nanoscopic pores found in purpose-built filters, sensors, or diffraction gratings to make them function better. As activated carbon, they may also be used as an alternative fuel storage medium, due to their massive internal surface area. Scientists believe nanopores, tiny holes that allow DNA to pass through one strand at a time, will make DNA sequencing more efficient. In biology, they are complex protein assemblies that span cell membranes and allow ionic transport across the otherwise impermeable lipid bilayer. A nanopore can be a protein channel in a lipid bilayer or an extremely small isolated 'hole' in a thin, solid-state membrane such that DNA and RNA, can be registered and characterized singly.

**Nanopipettes:** Cantilevered/Straight Nanopipettes can be used as nanopens for controlled chemical delivery or removal from regions as small as 100 nanometers. They can also be used as vessels for containing molecules whose optical properties change in response to their chemical environment. Other uses include controlled chemical etching with the precision of atomic force microscopy; chemical imaging of surfaces; delivering femtosecond laser pulses; and performing NSOM/SNOM imaging using a UV excimer laser.