Міністерство освіти і науки України

Національний технічний університет України
«Київський політехнічний інститут імені Ігоря Сікорського»

Англійська мова професійного спрямування. Технічні та програмні засоби автоматизації

Частина І

Навчальний посібник

Рекомендовано Методичною радою КПІ ім. Ігоря Сікорського
як навчальний посібник для здобувачів ступеня бакалавра
за освітньою програмою «Технічні та програмні засоби автоматизації»
спеціальності 174 Автоматизація, комп'ютерно-інтегровані технології та робототехніка

Електронне мережеве навчальне видання

Київ
КПІ ім. Ігоря Сікорського

УДК 811.111'276.6:[681.5+004.9](075.8)
А64

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А64 Англійська мова професійного спрямування. Технічні та програмні засоби автоматизації. Частина І [Електронний ресурс] : навч. посіб. для здобувачів ступеня бакалавра за освіт. програмою «Технічні та програмні засоби автоматизації» спец. 174 Автоматизація, комп'ютерно-інтегровані технології та робототехніка / КПІ ім. Ігоря Сікорського ; уклад.: Н. В. Ямшинська та ін. – Електрон. текст. дані (1 файл). – Київ : КПІ ім. Ігоря Сікорського, 2025. – 332 с.

Професійно-орієнтовані теми "Automation and Process Control Systems", "Sensors, Actuators, Controllers", "Software for Control Systems", "Computer Industrial Networks", "Mathematical Modeling", "Data Visualization", "Basics of Robotics" викладено в семи розділах, кожен розділ містить автентичні англомовні тексти з розробленими до них вправами. Мета посібника – формування у студентів здатності і готовності до комунікації англійською мовою в сфері професійної діяльності інженера.

Навчальний посібник призначений для здобувачів ступеня бакалавра за спеціальністю 174 Автоматизація, комп'ютерно-інтегровані технології та робототехніка інженерно-хімічного факультету, сприятиме формуванню навичок, розвитку і вдосконаленню вмінь в усіх видах мовленнєвої діяльності, буде також корисним для використання в поза аудиторний час.

УДК 811.111'276.6:[681.5+004.9](075.8)

Реєстр. № 23/24-001. Обсяг 15 авт. арк.

Національний технічний університет України
«Київський політехнічний інститут імені Ігоря Сікорського»
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Свідоцтво про внесення до Державного реєстру видавців, виготовлювачів і розповсюджувачів видавничої продукції ДК № 5354 від 25.05.2017 р.

ПЕРЕДМОВА

Навчальний посібник «Англійська мова професійного спрямування. Технічні та програмні засоби автоматизації. Частина І» розроблено для студентів третього курсу спеціальності 174 «Автоматизація, комп'ютерно-інтегровані технології та робототехніка» інженерно-хімічного факультету з метою формування професійної англомовної компетентності.

Навчальне видання відповідає вимогам силабусу навчальної дисципліни «Практичний курс іноземної мови професійного спрямування» і може використовуватися як для роботи на заняттях з викладачем, так і для самостійної роботи студентів, що дає можливість студентам працювати над власними навчальними потребами.

Навчальний посібник складається з семи розділів, кожен з яких охоплює різні аспекти технічних та програмних засобів автоматизації та англійської мови ("Automation and Process Control Systems", "Sensors, Robotics"). Кожен розділ навчального посібника містить автентичні англомовні тексти за фахом та розроблені до них вправи (некомунікативні, умовно-комунікативні, комунікативні).

Розроблені комплекси вправ сприяють розвитку всіх видів мовленнєвої діяльності: говоріння, читання, аудіювання та письма. У кінці кожного розділу студентам пропонуються завдання на самоперевірку – картки з лексикою (Quizzlet) і тести на множинний вибір, що спряє закріпленню знань та вдосконаленню іншомовних умінь.

Рефлексія та самоцінювання є однією з ключових особливостей цього навчального посібника, що дозволяє студентам оцінити свій прогрес та перспективи подальшого розвитку. Такий підхід допомагає студентам оцінити свої сильні та слабкі сторони, зрозуміти які навички потребують

вдосконалення. Завдання на рефлексію мотивує студентів до самоорганізації та відповідальності за власне навчання.

Крім того, навчальний посібник містить корисні додатки для студентів: словник до кожного розділу, методичні рекомендації до написання доповідей та інших письмових завдань. З метою кращого запам'ятовування матеріалу та підвищення мотивації студентів до вивчення англійської мови професійного спрямування, навчальний посібник містить різноманітні графічні матеріали, такі як словесні хмаринки, ілюстрації, відео та інші візуальні засоби. Використання візуальних елементів допомагає зрозуміти складні поняття та краще засвоїти матеріал, робить освітній процес цікавим та зрозумілим для студентів.

Розроблений методичний матеріал в навчальному посібнику сприяє формуванню професійно орієнтованих англомовних компетентностей в читанні, говорінні (діалогічному і монологічному мовленні), аудіюванні та письмі у студентів третього курсу інженерно-хімічного факультету.

Unit 1


adjust
sensor
automation
DCS
signal
intervention
integration
sophistication
complexity
cost
control
labor
assembly
threshold
line
range
utilize
rule
depend
performance
precision
manual
measure
desire
mechanism
reduce
trigger
consistent
monitor
regulation
process
system
learn
industrial
datum
logic
error
human
rely
eliminate
quality
distribute
setting
ensure
manufacture
workflow
productivity
advancement
rate
feedback
core
involve
predefine
pressure

LEAD-IN

1

A

B

C

D

E

F

G

H

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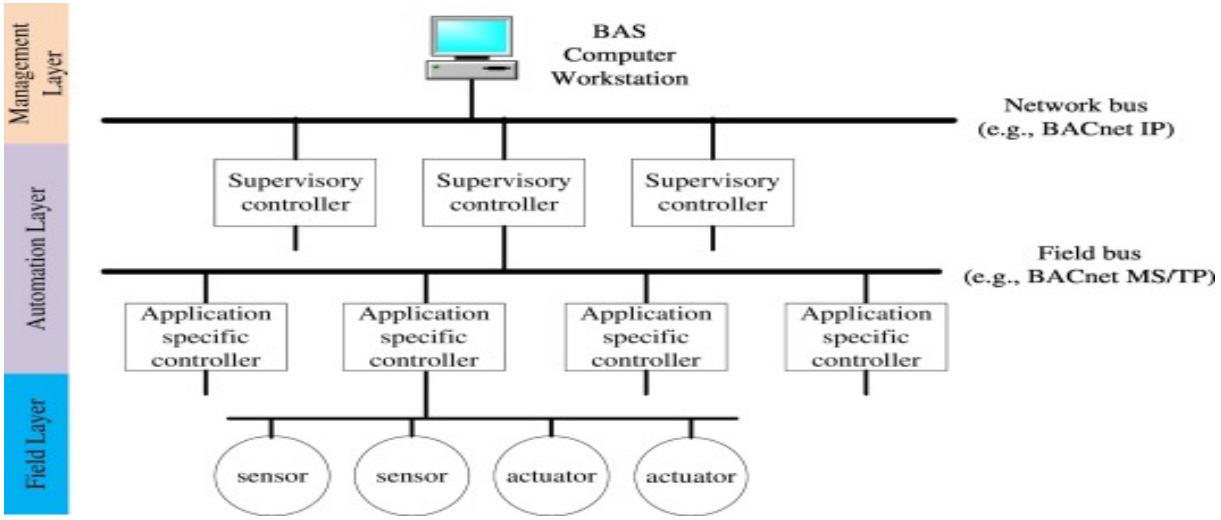

3

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1.		**A**	Advanced sensors and controls allow us to monitor every aspect of the production process. We can quickly detect and address any issues, minimizing downtime and keeping the production line running smoothly.
2.		**B**	For renewable energy sources like wind and solar, control automation systems are critical for maximizing energy output and efficiency. They allow us to adjust settings based on real-time environmental conditions.

3.		**C**	Automation helps us ensure that clean, safe water is delivered to consumers while also protecting the environment through efficient wastewater treatment.
4.		**D**	Medical devices with automated controls allow us to deliver precise, reliable care to patients. For example, infusion pumps can administer medication at the exact dosage and rate needed, ensuring patient safety.
5.		**E**	Home automation systems provide convenience and energy savings. They allow homeowners to control lighting, temperature, and security remotely, creating a comfortable and secure living environment.
6.		**F**	In logistics and shipping, automated systems streamline operations, optimize routes, and track shipments in real time. This enhances efficiency and customer satisfaction.

7.		G	Precision agriculture relies on control automation systems to optimize crop yield and resource use. Sensors in the soil and air provide data that control systems use to adjust irrigation, fertilization, and other factors.

READING

4. ***Read the text below. Match choices (A-H) to (1-5). There are three choices you do not need to use. Fill in the table with your answers.***

1 _____

2 _____

3 _____

tion of data, analysis of that data, and the execution of actions based on the analysis. Here's a breakdown of how automation control works:

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USE of ENGLISH

	Column A		Column B
1.	assembly	A	error
2.	automated	B	line
3.	reliable	C	learning
4.	human	D	buildings
5.	flow	E	role
6.	industrial	F	manner
7.	machine	G	intervention
8.	manual	H	decisions
9.	quality	I	performance
10.	residential	J	range
11.	to make	K	rate
12.	to reduce	L	settings
13.	wide	M	processes
14.	manufacturing	N	costs
15.	crucial	O	control

8. ***Explain the meanings of the phrases in column A. Then complete the sentences in column B with your ideas.***

	Column A	Column B
1.	distributed control systems	By managing complex processes, *distributed control systems* in factories foster …
2.	to increase productivity	Companies aim *to increase productivity* by implementing new technologies, such as ...
3.	industrial automation control	*Industrial automation control* plays a crucial role in modern factories because it allows ...
4.	integration of sensors	The *integration of sensors* in manufacturing processes helps to monitor ...
5.	level of sophistication	As the *level of sophistication* in technology increases, companies are able to ...
6.	manual labor	Reducing *manual labor* in production can lead to ...
7.	predefined rules	Systems that follow *predefined rules* can help ensure that ...
8.	production line	On a *production line*, automation can be used to improve ...
9.	to pave the way	These innovations are *paving the way* for a future where ...
10.	wide range of industries	A *wide range of industries* benefit from automation because it increases …
11.	to ensure consistency	*To ensure consistency* in our manufacturing process, we need to ...
12.	set points	*Set points* are crucial in automation systems because they allow for ...
13.	to eliminate human error	*To eliminate human error* during data entry, companies often ...

14.	advancement of technology	The *advancement of technology* has made it possible to ...
15.	target system	The *target system* must be thoroughly tested before we can ...

9

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1. to monitor and _____ the operations;

2. reliability in a wide _____ of industries;

3. rely on _____ logic controllers (PLCs);

4. can be found in various _____ ;

5. industrial _____ control;

6. utilized to manage _____ processes;

7. security _____ in commercial and residential buildings;

8. plays a _____ role in modern industries;

9. automation control is becoming increasingly _____ ;

10. _____ various technologies and components;

11. process involves the _____ of data;

12. sensors can _____ parameters;

13. to detect any _____ ;

14. the system might _____ cooling mechanisms;

15. actions to regulate or _____ the target system.

1

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1

1.

	Column A		Column B
1.	monitor	A	accuracy
2.	various	B	consolidation
3.	manner	C	use
4.	eliminate	D	control
5.	precision	E	complicated
6.	efficiency	F	failure
7.	integration	G	pre-established
8.	features	H	way
9.	utilize	I	productivity
10.	complex	J	characteristic
11.	incorporate	K	verge
12.	breakdown	L	different
13.	predefined	M	guarantee
14.	threshold	N	remove
15.	ensure	O	include

1

2.

manual intervention | pattern | distributed control systems (DCS) | automation control
manual labour | actuator | controller | accuracy | reliability | sensor | adjustment
assembly line | human error | deviation | programmable logic controllers (PLCs)

1. An instrument that reacts to certain physical conditions or impressions such as heat or light, and which is used to provide information.

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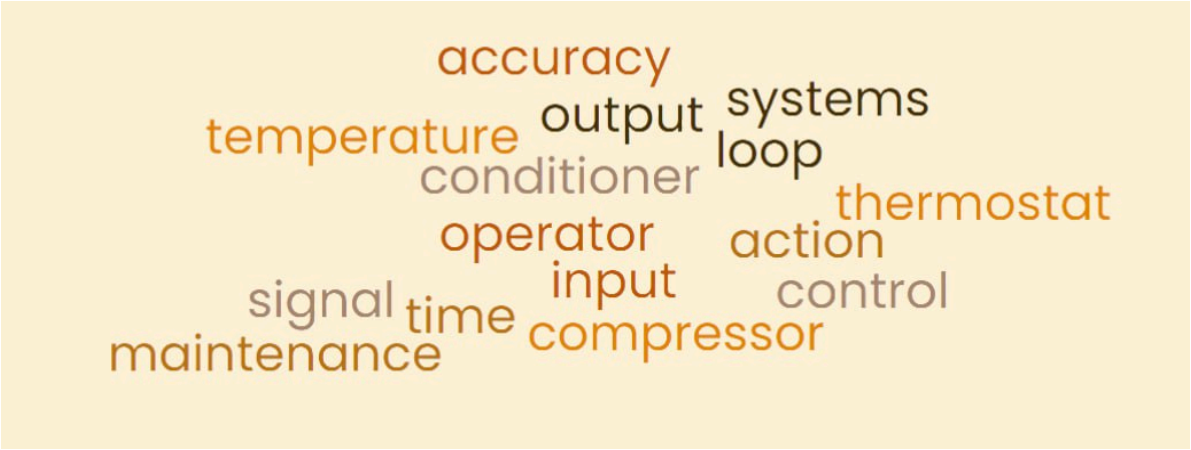

Types of Control Systems

Control systems are classified into two types like open ***1)*** _____ and closed loop. The main difference between open-loop and closed-loop control ***2)*** _____ is, that the required output within the open-loop doesn't depend on the controlled act whereas, in closed-loop, the required ***3)*** _____ mainly depends on the controlled act.

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The main advantages of the closed-loop ***11)*** _____ system are accurate, expensive, reliable, and requires high maintenance. The best example of a closed-loop control system is AC or air ***12)*** _____. The AC controls the ***13)*** _____ by evaluating it with the nearby temperature. The evaluation of temperature can be done through the ***14)*** _____. Once the air conditioner gives the error signal is the main difference between the room and the surrounding temperature. So the thermostat will control the ***15)*** _____ . These systems are accurate, expensive, reliable, and require high maintenance.

Adopted from https://www.elprocus.com/difference-between-open-loop-closed-loop-control-system/

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What sets IIoT apart is its unique convergence of information technology (IT) and operational ***6)*** _____ (OT). OT involves networking operational processes and industrial ***7)*** _____ systems. This comprehensive approach ensures that IIoT plays a pivotal role in reshaping industrial ***8)*** _____ and facilitating data-driven decision-making.

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Connected **9)** _____ and actuators enable companies to pick up on inefficiencies and problems sooner, saving time and money while also supporting business intelligence **10)** _____. Sensors acquire data from the surrounding environment and the objects they monitor and then transform the information into **11)** _____ and numbers that the Internet of Things platform can analyze and turn into actionable insights. The **12)** _____ controls the processes that occur in the observed environment. IIoT uses the power of smart **13)** _____ and real-time analytics to take advantage of the data that dumb machines have produced in **14)** _____ settings for years. The driving philosophy behind **15)** _____ is that smart machines are better than humans at capturing and analyzing data in real-time.

1.	**a)** *continuation*	**b)** *extension*	**c)** *development*
2.	**a)** *communication*	**b)** *action*	**c)** *reaction*
3.	**a)** *numerals*	**b)** *data*	**c)** *numbers*
4.	**a)** *reaction*	**b)** *productivity*	**c)** *efficiency*
5.	**a)** *maintenance*	**b)** *production*	**c)** *control*
6.	**a)** *technique*	**b)** *technology*	**c)** *process*
7.	**a)** *manual*	**b)** *automatic*	**c)** *control*
8.	**a)** *manufacture*	**b)** *processes*	**c)** *production*
9.	**a)** *sensors*	**b)** *indicators*	**c)** *controllers*
10.	**a)** *effectiveness*	**b)** *efficiency*	**c)** *efforts*
11.	**a)** *indicators*	**b)** *controllers*	**c)** *sensors*
12.	**a)** *controller*	**b)** *actuator*	**c)** *motor*
13.	**a)** *mechanisms*	**b)** *devices*	**c)** *machines*
14.	**a)** *industrial*	**b)** *network*	**c)** *productional*
15.	**a)** *IT*	**b)** *IIoT*	**c)** *computers*

Grammar Box

Present Tenses

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_____ is used to talk about regular events, permanent states, and timetables.	
_____ is used with stative verbs, which express mental states, preferences, possessions etc.	
_____ is used to talk about temporary situations, actions being performed at the moment of speaking, changing or developing situations, and irritation (with words *always, never)*.	
The phrase "to be going to" or _____ is used to talk about fixed plans for the near future.	
_____ is used to talk about actions that have started and are not finished yet.	
_____ is used to talk about completed recent actions that impacted the present, actions in the past when time is not stated, or to express the number of times the situation has happened.	

_____ is used to talk about the duration of recent situations or irritation about the recent event.	*Optima Automation Systems has been manufacturing a wide range of Industrial Automation Systems and Robotic Equipment for the past 10 years.*

16. ***Match the rule of using*** **Present Simple, Present Continuous, Present Perfect,** ***and*** **Present Perfect Continuous** ***with the examples of their use in the sentences.***

1.	*regular event*	**A.**	A manufacturing facility's automation requires the planning and building of a control system, which calls for sensors, instruments, computers, and data processing.
2.	*permanent state*	**B.**	These automated control systems are always driving me crazy with their constant glitches and errors!
3.	*timetable*	**C.**	More and more problems are occurring as a result of the swift increase in production with the rapidly developing technology.
4.	*stative verb*	**D.**	Automation systems often incorporate control systems that process data from sensors and make decisions or adjustments based on predefined parameters or algorithms.
5.	*temporary situation*	**E.**	Our business is working now to create intelligent technologies that will link your security, detection, lighting, and HVAC systems.
6.	*irritation*	**F.**	Automated control systems aim to streamline workflows, increase efficiency, reduce manual effort, and improve accuracy in performing repetitive or complex tasks.
7.	*changing or developing situation*	**G.**	Our engineers update the timetable for maintenance tasks on the automated control system every day at 6 a.m.
8.	*future fixed plans*	**H.**	We have started studying the behavior of the open loop system which is determined solely by a predetermined

			set of instructions (inputs), without any feedback from the system.
9.	*action performed at the moment of speaking*	**I.**	This year we are implementing A SCADA system at our manufacturing facilities aimed to provide a user at a remote location with the same access to the particular process as an operator literally "standing in front of the equipment."
10	*action has started but is not finished*	**J.**	The Control Engineering Program is providing training in the design and implementation of computer-based industrial information systems tomorrow at 7 p.m. in office 305.
11	*recent action*	**K.**	Since morning engineers have been adjusting the drive command in real time using live feedback from the closed-loop control system.
12	*action in the past with unstated time*	**L.**	Why have you been troubleshooting the automation control systems all day and can't obtain the desired response?
13	*expressing the number of times the situation has happened*	**M.**	The field of engineering known as "Control and Automation Engineering" has emerged as a result of the application of the knowledge gained from research in industry and other production systems.
14	*irritation about the recent event*	**N.**	It was claimed that our engineers have demonstrated the highest levels of expertise in automation, electrical equipment, and processes during the competition.
15	*focusing on the duration of the recent situation*	**O.**	The "Oil, Gas & Chemistry Service, Ltd." company has already demonstrated new designs of automated process control systems a few times at international exhibitions and has always been successful.

17. ***Read the abstract and open the brackets, using*** **Present Simple, Present Continuous, Present Perfect,** ***and*** **Present Perfect Continuous.**

Industrial automation in the era of intelligence **1)** _____ (TRANSFORM) centralized control into decentralized enhanced control under the original automation technology and architecture. Market requirements and technology capabilities both **2)** _____ (UNDERGO) significant changes in recent years, and continue to do so. With the large-scale, continuous, and highly parameterized industrial devices, the requirements for industrial automation systems constantly **3)** _____ (INCREASE).

In the business environment, globalization **4)** _____ (LEAD) to increased worldwide competition. It is not only Western companies that **5)** _____ (USE) offshore production to lower their cost; more and more companies from upcoming regions such as China and India that **6)** _____ (GO) global and increasing competition.

In this environment, automation technology **7)** _____ (BENEFIT) from the rapid developments in the information technology (IT) industry. Whereas some 15 years ago automation technology was mostly proprietary, today it **8)** _____ (BUILD) on technology that is being applied in other fields. Boundaries that have clearly been defined due to the incompatibility of technologies are now fully transparent and **9)** _____ (ALLOW) the integration of various requirements throughout the value chain. Control systems **10)** _____ (SURPASS) previous limits, offering unmatched precision and intelligent features. Emerging technologies (Artificial intelligence (AI); Industrial Internet of Things (IoT); Machine learning (ML) for optimization) **11)** _____ (HAVE) transformative potential for controls engineering. These new technological developments **12)** _____ (PROMOTE) the development of industrial automation technology to the direction of intellectualization.

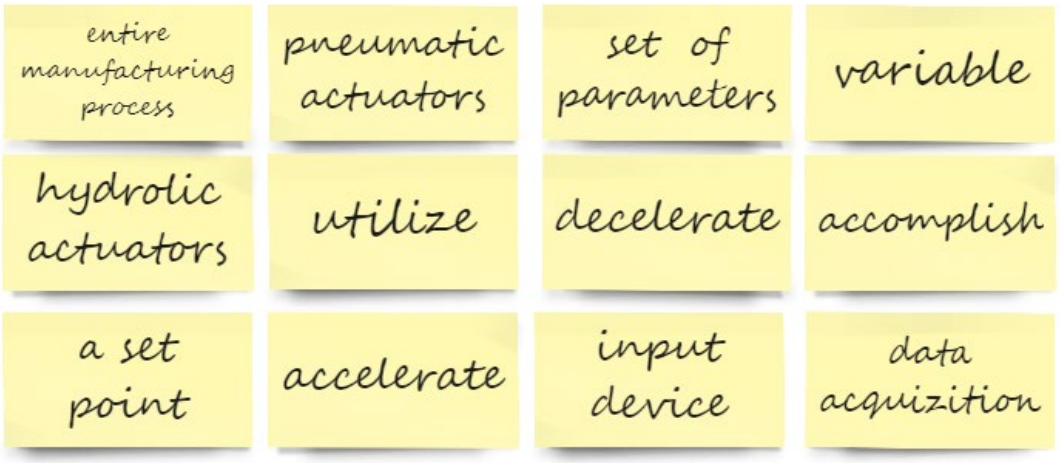
More and more control and automation companies **13)** _____ (MANUFACTURE) simplified control and data acquisition systems that are used for remote monitoring and management of manufacturing operations.

To achieve the desired return, companies already **14)** _____ (EXPLOIT) all possibilities to further improve their production or services. This **15)** _____ (AFFECT) all automation levels from field to enterprise optimization, all lifecycle stages from plant erection to dismantling, and all value chain steps from procurement to service.

Adapted from:

LISTENING

18.



19.

A. Where the previous level utilizes PLCs, this level utilizes SCADA.

B. The third level of the automation pyramid is known as the supervisory level.

"What is the automation pyramid?" and put the sentences in the correct order.

C. ERP (Enterprise Resource Planning) is usually a suite of different computer applications that can see everything going on inside a company.

D. These are the devices, actuators, and sensors that you see in the field or on the production floor.

E. Beginning on the bottom of the pyramid is what we will refer to as the field level.

F. The control level uses these devices to control and run the devices in the field level that do the physical work.

G. SCADA is essentially the combination of the previous levels used to access data and control systems from a single location.

H. A common example that you probably use every day is your cruise control.

I. Many systems and manufacturing plants have to be heated.

J. MES (Manufacturing Execution System) monitors the entire manufacturing process in a plant or factory from the raw materials to the finished product.

K. They can adjust raw material orders or shipment plans based on real data received from the systems we talked about earlier.

L. This level uses the company's integrated management system which is known as the ERP or Enterprise Resource Planning.

2

0 **1.** If you think of it this way, the field level is the production floor that does the _____ work and monitoring.

2. When a set point is entered, the PID will _____ when the PLC needs to turn the heater on and off to maintain a constant temperature.

3. This is where the _____ and PIDs come into play.

4. Plus it usually adds a graphical user interface or an HMI to control functions _____ .

5. Proximity switches used to detect that _____ or certain materials, and photoelectric switches that detect similar things will all play a part in the field level.

6. The important thing to remember about SCADA is that it can monitor and control _____ systems from a single location.

7. You set your cruise control to whatever speed you want then a set of _____ and the computer in the car will tell it when to accelerate or decelerate according to the set speed.

8. They take in information from all of the sensors, _____ , and other input devices to make decisions on what outputs to turn on to complete the programmed task.

9. A PID is usually _____ into the PLC and stands for Proportional Integral Derivative.

10. Water plants will often employ this technology to control _____ water pumps in their systems.

11. This allows the business to be able to _____ all levels of the business from manufacturing to sales to purchasing to finance and payroll plus many others.

12. The integration of the ERP promotes _____ and transparency within a company by keeping everyone on the same page.

SPEAKING

2

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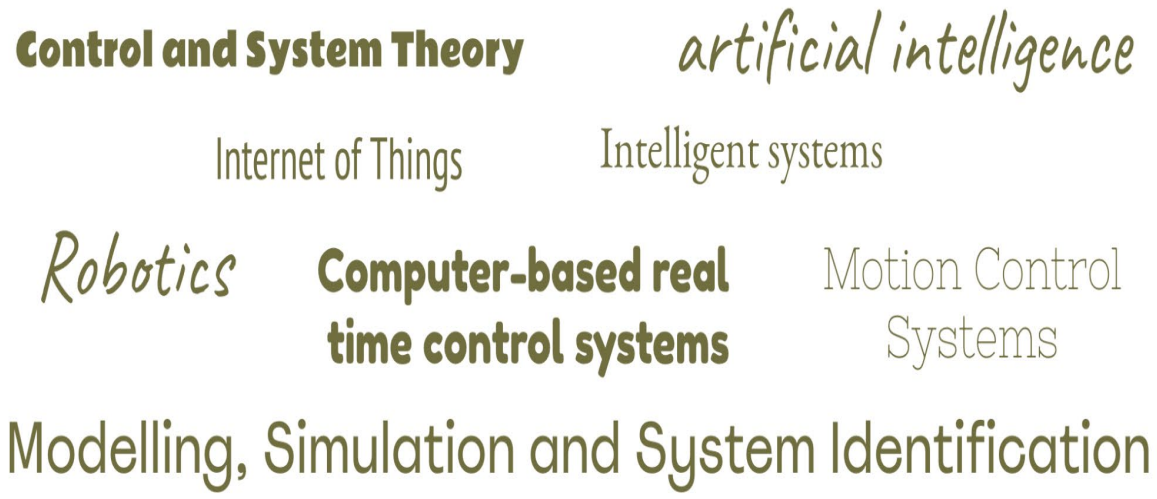
..., firstly ..., in addition ...,

..., for example ..., to conclude ..., last but not least ...



2

2

cutting-edge	breakthough	state-of-the-art technology	pioneering	emerging trends
next-generation solution	adaptive	predictive	monitoring	analytics
machine learning	algorithms	cloud-based	virtualization	data-driven

2

3

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- ✓ *In my opinion … …*
- ✓ *From my point of view … …*
- ✓ *From my viewpoint … …*
- ✓ *From my perspective … …*
- ✓ *It appears to me that … …*
- ✓ *I realize that … …*
- ✓ *I understand that … …*

2

4

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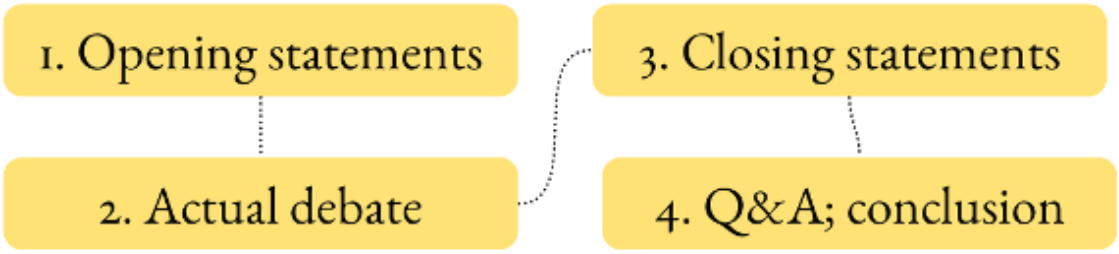
debate: Automation vs. Manual control. Group A's role is to advocate for automation control systems. Group B's role is to advocate for manual control.

Useful phrases for debating:

- ✓ *To start with, I'd like to point out … …*
- ✓ *Speaking of … …*
- ✓ *My first / second / … / next argument is … …*
- ✓ *An argument for / in favour of / against if … …*
- ✓ *There are many examples for … …*
- ✓ *I'm afraid I can't quite agree with … …*
- ✓ *To sum up, here are the main points … …*



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WRITING

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25. ***You were invited to participate in an international convention on automation control systems. Write a report (160-180 words) exploring the historical background, evolution, and current position of automation control systems.***

A
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- ✓ *The aim / purpose of this report is to outline / present / discuss … …*
- ✓ *The term … is used to describe … …*
- ✓ *This (technology) finds application in / can be incorporated … …*

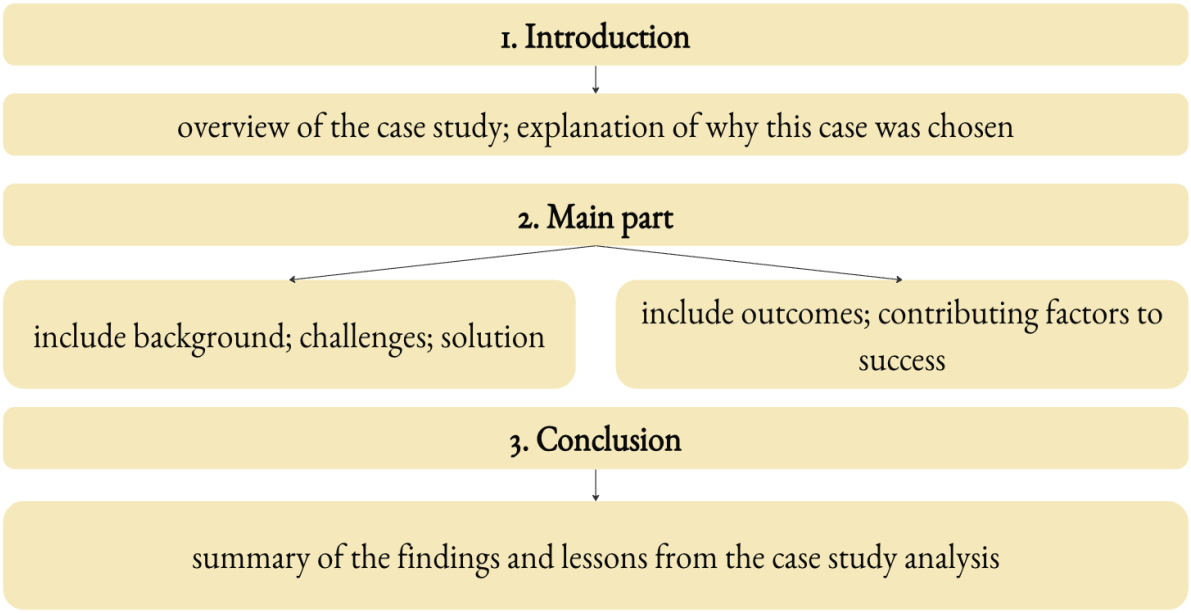
- ✓ *Now let's focus on … …*
- ✓ *It is apparent / obvious / clear / evident that … …*
- ✓ *Looking ahead … …*
- ✓ *In conclusion / summary … …*

industrial revolution	breakthough	pioneering	emerging	Internet of Things
microprocessors	digital computing	artificial intelligence	robotics	autonomous systems
machine learning	efficiency	productivity	safety	innovation

2

6.

- ✓ *The aim / purpose is … …*
- ✓ *Then / next … …*
- ✓ *According to … …*
- ✓ *Overall … …*
- ✓ *In brief … …*
- ✓ *To outline … …*
- ✓ *In summary / conclusion … …*



REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic*** **"Automation Control Systems"** ***using flashcards and then assess comprehension through a Quizlet quiz.***

28. ***Self-assessment test.***

1. What system is commonly used for the automation of complex and distributed industrial processes?

A. Distributed Control Systems (DCS)

B. Human Error Systems (HES)

C. HVAC systems

D. Manual Control Systems (MCS)

2. Which term refers to a computational model that allows computers to understand patterns and forecast?

A. Manual labor

B. Automated manner

C. Machine learning algorithm

D. Human intervention

3. What is used to selectively sample and measure many physical properties?

A. Actuator

B. Pressure

C. Feedback

D. Integration of sensors

4. Which system ensures monitoring and control in processes, so that only a few people are needed to carry them out?

A. Quality Control

B. Human Error Control

C. Automation Control

D. Manual Control

5. What technology refers to a tiny computer that can receive data through its inputs and send operating instructions through its outputs?

A. HVAC systems

B. Programmable Logic Controllers (PLCs)

C. distributed control systems

D. assembly line

6. Which term refers to how well a machine, piece of equipment, or system works?

A. usefulness

B. complexity

C. advancement

D. reliability

7. Which noun explains a track of machines and workers in a factory that a product moves along while it is being built or produced?

A. assembly line

B. desired range

C. human error

D. flow rate

8. Which word best defines the expression ‘complete and true in every detail’?

A. accurate

B. core

C. intervention

D. thresholds

9. Which word defines a point at which something starts?

A. intervention

B. threshold

C. quality control

D. workflow

10. What is the best definition of the idiomatic expression ‘pave the way’?

A. make things possible

B. reduce costs

C. rely on

D. utilize

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas, and concepts were easy to understand.*	***Yes / No / Partially***
Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I used terms and concepts to discuss automation control systems. I expanded my vocabulary, incorporating new terms, and used them actively during the lessons.*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic is easy and now I can discuss relevant ones.*	***Yes / No / Partially***
Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***

Learning experience	*I think understanding the concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of automation control systems.*	***Yes / No / Partially***

You didn't choose "Yes" for each statement? Don't worry! Turn

Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*
Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look it up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, writing down new vocabulary, learning through media, learning from the context. Use can visit,* ***https://youglish.com/*** *an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*
Listening	*Focus on improving your listening comprehension by watching English-language media.*
Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*

Speaking	*Don’t be afraid to make mistakes while speaking. Feel free to express your opinion, even if you think it doesn’t correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*
Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience.* *Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

Unit 2

SENSORS, ACTUATORS, CONTROLLERS

LEAD-IN

robot vacuum cleaner, smart washing machine, automatic coffee maker, automatic pet feeder, automated lawn mower, smart thermostat, smart refrigerator, smart lighting system

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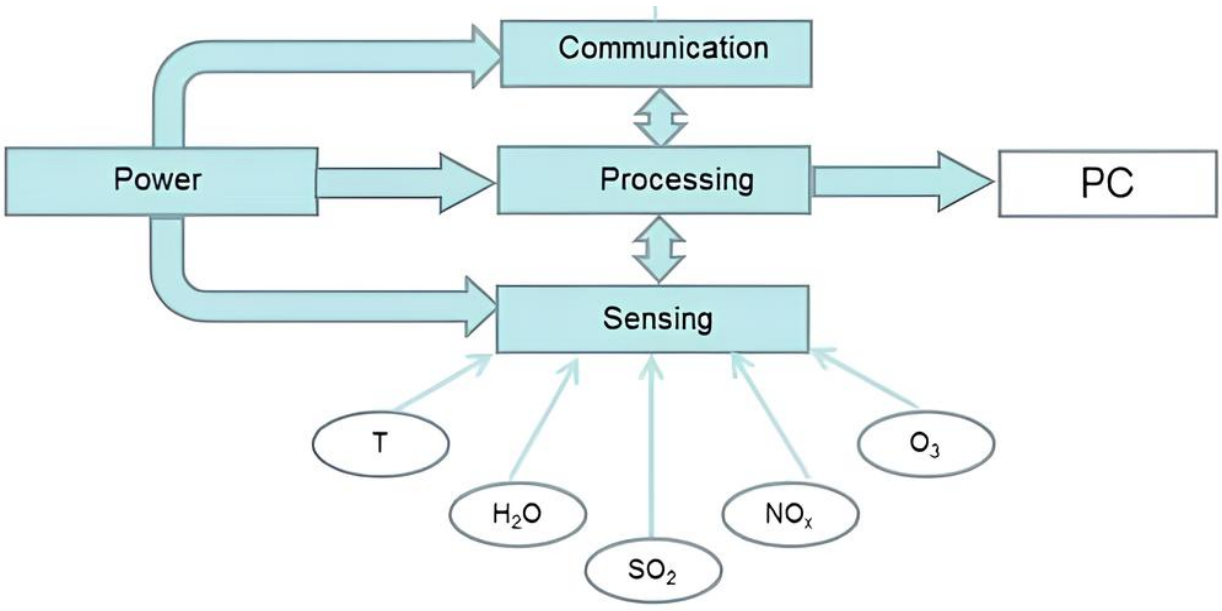
B


Communication
Power
Processing
PC
Sensing
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H_2O
SO_2
NO_x
O_3

3

READING

A

Under***B***anding sensors: translating physical quantities into electrical signals.

Essen***C*** Key components of sensor technology.

D

Actua***E***rs: driving precision motion in robotic systems.

Under***F*** The range of industries where sensors are commonly utilised.

G Actuators: efficiency, control mechanisms, and potential limitations.

H Feedback control systems in motion control.

The Control systems are an integral part of the various engineering and automation processes. They are responsible for regulating the behavior of the dynamic systems to achieve desired outcomes.

1 _____

Actuators, sensors, and controllers are vital components of embedded and electronic systems. Actuators form a link with the output ports while sensors connect to the input ports of a given system. These components are used to facilitate efficient output in many real-life applications such as process control systems in nuclear reactors, home automation and security systems, and aircraft flight control systems. Both actuators and sensors play a significant role in

condition-based maintenance. Plus, they serve as a mediator between the electronic system where they are embedded and the physical environment.

The controllers are the major controlling element in a process in a control system. So, in a control system, the controller would compare the controlled value to the required value, and if there is an error or deviation from the required value, the controller would correct it.

2 _____

An actuator is a device that takes an electrical signal (control input) and blends it with an energy source to create movement. Typically, actuators receive control input in the form of electric current or voltage, but they can also accommodate hydraulic fluid and hydraulic or pneumatic pressure. The device then uses the control signal to generate a change in the physical system by generating motion, heat, or force. Popular examples of actuators include hydraulic cylinders, comb drives, and electric motors. A stepper motor where an electrical pulse drives a motor is also a common example of an actuator.

Of course, electric actuators receive their power from an electronics circuit. Some examples of this actuator type are servo motors, stepper motors, and AC motors. Then, there are hybrid actuators that have electric controls integrated in addition to the current elements. You can find these actuators in advanced applications, like robots and IoT devices.

3 _____

A sensor is an electronic instrument that translates real-world parameters into electrical signals. It can take the shape of a basic switch or be a more complicated sensor, depending on the application. Sensors are integrated in a way that they can interact with the surrounding environment to sense the input energy. The primary function of a sensor is to measure a specific physical quantity, such as temperature, pressure, or acceleration, and convert it into a usable output signal, typically an electrical voltage or current.

A typical sensor consists of three main parts: the sensing element, the transduction element, and the signal processing unit.

4

Sensing Element: The sensing element is the part of the sensor that interacts directly with the environment. In a mobile phone's touch sensor, for instance, the sensing element might be a capacitive or resistive surface that detects changes in electrical properties when touched.

Transduction Element: The transduction element converts the sensed physical quantity into an electrical output. For instance, in a thermostat's thermistor or RTD, the transduction element changes its resistance in response to temperature variations, producing an analog signal that reflects these changes.

Signal Processing Unit: This unit interprets the electrical signal from the transduction element, making it usable for the system it's integrated into. In robotics, this could involve converting the analog signal from a force sensor into a digital signal that a microcontroller can interpret to control an actuator.

5

The controller normally has a pre-set speed, which in control terms, is known as the set point or set value (SV). The operator selects this as the required speed. The motion sensor sends a signal to a comparator block within the controller. This signal is then compared to that value chosen by the operator and the difference, or error, is then used to either slow or speed up the motor until the two signals are the same, which is how feedback control works.

The controller sends signals to the drive based on the desired motion profile. The drive modulates the power supplied to the motor, according to the control signals. The motor converts electrical power into mechanical motion, moving the load.

Feedback sensors continuously monitor the actual motion and provide feedback to the controller, which uses the feedback information to adjust the control signals, ensuring that the system maintains the desired motion characteristics.

1. Actuators, sensors, and controllers are essential components of embedded and electronic systems, facilitating effective output in various practical uses.

2. Actuators receive control input and generate movement by combining electrical signals with an energy source.

3. Actuators primarily serve as mediators between electronic systems and the physical environment.

4. A sensor interprets real-world data into electrical signals and interacts with the surrounding environment to sense input energy.

5. Sensors lack the ability to engage with the surrounding environment in order to detect input energy.

6. Popular examples of actuators exclude stepper motor, hydraulic cylinders, comb drives, and electric motors.

7. An average sensor comprises a sensing component, a transduction component, and a signal processing module.

8. The drive does not affect the power supplied to the motor, despite receiving control signals, and the motor does not convert electrical power into mechanical motion to move the load.

9. The controller parallels the controlled values to the required values and corrects errors in control systems, ensuring desired outcomes.

10. The controller occasionally has a pre-set speed, which in control terms, is known as the set point or set value (SV).

11. Feedback sensors consistently observe real-time motion and relay this information to controllers for necessary adjustments, ensuring the retention of desired motion traits.

12. Actuators receive their power from mechanical sources rather than electronic circuits.

USE of ENGLISH

	Column A		Column B
1.	analog	A	cylinder
2.	comb	B	element
3.	electrical	C	drive
4.	electronics	D	signal
5.	hydraulic	E	variations
6.	input	F	environment
7.	nuclear	G	pressure
8.	physical	H	pulse
9.	resistive	I	surface
10.	sensing	J	circuit
11.	set	K	reactor
12.	temperature	L	value
13.	stepper	M	applications
14.	real-life	N	ports
15.	pneumatic	O	motor

8. ***Explain the meanings of the phrases in column A. Then complete the sentences in column B with your ideas.***

	Column A	**Column B**
1.	alternating current	*Alternating current* is widely used in electrical systems because it ...
2.	flight control system	The *flight control system* in modern aircraft ensures that ...

3.	electrical voltage	*Electrical voltage* is essential in circuits as it ...
4.	hydraulic fluid	*Hydraulic fluid* plays a crucial role in machinery through ...
5.	hydraulic pressure	Maintaining proper *hydraulic pressure* is vital for the safe operation of ...
6.	process control systems	*Process control systems* are designed to optimize manufacturing by …
7.	servo motor	A *servo motor* is used in robotics to ...
8.	signal processing unit	The *signal processing unit* converts raw data into ...
9.	thermostat's thermistor	The *thermostat's thermistor* regulates temperature as it responds to ...
10.	electronics circuit	An *electronics circuit* is necessary for ensuring that ...
11.	to generate motion	*To generate motion* in a mechanical system, engineers often rely on ...
12.	to modulate the power output	*To modulate the power output*, the system must ...
13.	transduction element	A *transduction element* is critical in devices aimed at ...
14.	condition-based maintenance	*Condition-based maintenance* helps reduce downtime by ...
15.	comb drive	The *comb drive* technology is utilized in microelectromechanical systems to ...

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desired outcomes;

the controlled value to the required value;

hydraulic fluid and pneumatic pressure;

change in the physical system;

or resistive surface that detects changes;

the sensed physical quantity into an electrical output;

to temperature variations;

the desired motion characteristics.

y	e	r												
	a													
			t											

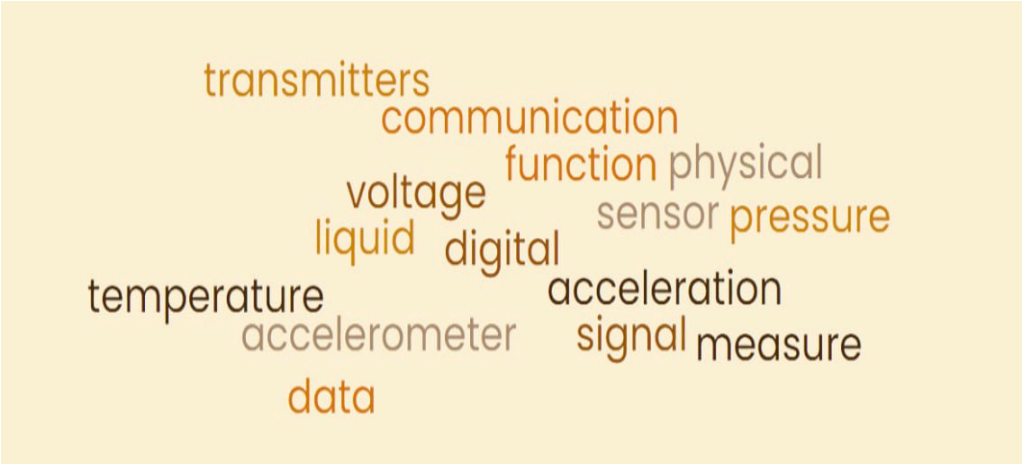
1

1.

	Column A		Column B
1.	specific	A	element
2.	outcome	B	link
3.	component	C	produce
4.	embedded	D	modern
5.	connect	E	particular
6.	significant	F	mix
7.	blend	G	movement
8.	generate	H	use
9.	motion	I	result
10.	advanced	J	spot
11.	application	K	change
12.	detect	L	inbuilt
13.	variation	M	important
14.	select	N	adapt
15.	interpret	O	choose

dynamic system | value | pneumatic pressure | maintenance | voltage
stepper motor | nuclear reactor | current | force | embedded system
transduction | acceleration | parameter | hydraulic liquid | servo motor

x’ or ‘y’ in a mathematical expression.



Classification of Sensors

Sensors are classified on the basis of the output ***1)*** _____ , physical parameters measured by them, and various other points. Sensors on the basis of the output signal are classified into analog and ***2)*** _____ output sensors.

The output given by the sensors in the case of analog output sensors is an analog ***3)*** _____ that can be measured and used for determining the required physical parameter. This is done by making use of the sensor's transfer ***4)*** _____ . It may be resistive, capacitive, or anything which is analog.

The digital data that can be read via parallel or serial ***5)*** _____ buses is the output of digital output sensors. The format for the ***6)*** _____ , in this case, is demonstrated in the sensor's datasheet. An ***7)*** _____ sensor is an example of a digital ***8)*** _____ that is used for sending the output data by using the I2C two-wire bus.

The sensors are further classified on the basis of **9)** _____ parameters. Sensors for process monitoring **10)** _____ specific physical criteria and are therefore mainly: **11)** _____ sensors; pressure sensors; force sensors; electrical sensors; distance sensors; optical sensors; and velocity and **12)** _____ sensors.

Pressure sensors are being used for measuring **13)** _____ and can be a differential, gauge, or absolute. The most common types of pressure sensors that are used comprise transducers which are also known as pressure switches or pressure **14)** _____ .

Temperature sensors are put to use when it comes to monitoring and measuring the temperature of **15)** _____ , solid, and gas. It is the most commonly used sensor in homes and it is used in various shapes and sizes for serving different purposes.

Adopted from: https://www.tescaglobal.com/blog/what-is-a-sensor-and-types-of-sensors/

Sensors in Robotics

Robots equipped with sensors offer a number of **1)** _____ compared to more traditional machines, as they are capable of obtaining **2)** _____ from the environment and responding accordingly. For example, manufacturers may use **3)** _____ sensors to detect changes in the environment and adjust the speed, direction, and force of **4)** _____ accordingly. And by incorporating temperature and light sensors in robots, they are able to avoid any **5)** _____ environments.

In addition to the data they receive from their environment, **6)** _____ also need to be able to accurately detect and interact with objects of various materials and shapes. This is accomplished via **7)** _____ , tactile, and vision sensors. By combining the data obtained from these sensors, the robot can determine the best way to **8)** _____ with the environment.

For the human-robot interface, the **9)** _____ needs to detect the human's position, movements, and speech. In order to accurately **10)** _____ this, robots are programmed with a variety of **11)** _____ such as microphones, infrared and ultrasonic detectors, and sonar transducers. Through these sensors, the robot is able to **12)** _____ vocal commands, detect faces and gestures, and accurately navigate its way in unfamiliar environments.

Sensors not only enable robots to perceive the **13)** _____ around them, but also help robots to communicate with humans and other robots. This is particularly important for service and **14)** _____ robots, which require interfaces like speech and gestures to interact meaningfully with **15)** _____ . By using sensors and programming algorithms, these robots can understand and respond to natural language, facial expressions, and body gestures.

Adopted from: https://www.zivarobotics.com/sensors-actuators-robotics-work

1.	**a)** *advantages*	**b)** *disadvantages*	**c)** *characteristics*
2.	**a)** *information*	**b)** *numbers*	**c)** *data*
3.	**a)** *pressure*	**b)** *stress*	**c)** *strain*
4.	**a)** *movement*	**b)** *operation*	**c)** *action*
5.	**a)** *dangerous*	**b)** *polluted*	**c)** *unknown*
6.	**a)** *machines*	**b)** *robots*	**c)** *devices*
7.	**a)** *motion*	**b)** *action*	**c)** *direction*
8.	**a)** *do*	**b)** *act*	**c)** *interact*
9.	**a)** *sensor*	**b)** *robot*	**c)** *mechanism*
10.	**a)** *do*	**b)** *make*	**c)** *act*
11.	**a)** *controllers*	**b)** *sensors*	**c)** *actuators*
12.	**a)** *make*	**b)** *get*	**c)** *receive*
13.	**a)** *nature*	**b)** *world*	**c)** *humans*
14.	**a)** *social*	**b)** *industrial*	**c)** *special*
15.	**a)** *computers*	**b)** *people*	**c)** *robots*

Grammar Box

Present Tenses

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_ _ _ _	*Yesterday a group of engineers proposed a new design approach for sensor and actuator placement in process operation support systems.*
2 _____ is used with stative verbs, which express past mental states, preferences, possessions etc. Also, the e	
3 _ _	
4 _ _	
5 _ _	
6 _ _	
7 _ _	

1.	*past finished event at the stated time*	A.	A sensor was detecting changes in its environment when suddenly it malfunctioned, causing disruptions to the entire system.

2.	*past habit*	**B.**	Basic switches and relays served as the first primitive forms of automation.
3.	*actions happened immediately one after another in the past*	**C.**	Plant engineers had performed regular maintenance and calibration before they detected sensor failure.
4.	*past state*	**D.**	While *sensors* were observing and detecting changes in conditions, *actuators* were responding to signals by executing actions.
5.	*past continuous action interrupted by another one*	**E.**	In September 2020 we designed soft *sensors* and *actuators* for use in assistive applications for people with disabilities.
6.	*description of the past atmosphere*	**F.**	In the early stages, engineers used to rely on compressed air to control mechanical movements, making them ideal for industrial applications.
7.	*past continuous action at a stated time*	**G.**	Sensors and actuators had become closer to the heart of industrial automation with the widespread adoption of PLCs before 2001.
8.	*past action finished before another past action*	**H.**	Engineers chose the best sensors and actuators for the PLC system in plant engineering and then explained their main peculiarities.
9.	*past action finished by a stated time in the past*	**I.**	*Sensors* had been providing operators with three important data for control for several hours before the process continued.
10.	*past continuous action finished before another past action*	**J.**	Last Tuesday from 4 p.m. to 7 p.m. I was attending online *software engineering courses* to advance my computer programming and software development skills and career.

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Faraday’s diligence and curiosity and accepted the application. In 1813, he

LISTENING

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a pinion gear	stroke	move downwards	a rod
a rack gear	cylindrical chamber	a piston	compressed air
vane	circular motion	a spring	linear motion

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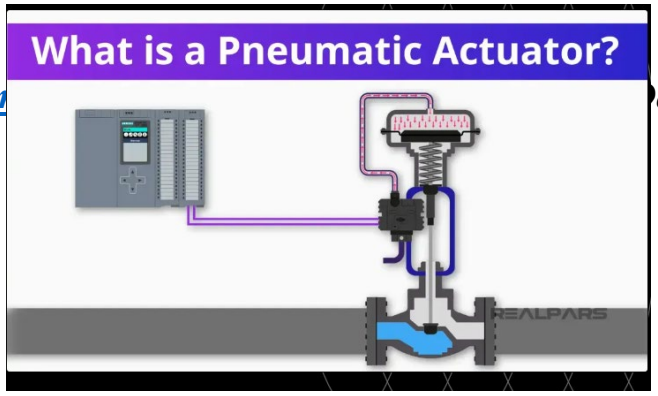


"What is a Pneum ecide whether the

1. Actuators make life easier for us every day and they are _____ of the industry.

2. The typical actuators in the industry include electric, _____, and pneumatic.

3. A _____ pneumatic actuator can move something in a straight line.

4. For example, a rod in a rack _____ drive system is used to produce rotary motion.

5. Pneumatic air under _____ applied on one side of the vane causes it to rotate through its stroke.

6. In the linear pneumatic actuator category, the _____ diaphragm style and the piston style are very common.

7. An air-to-extend motion can also be achieved by _____ the spring, piston, and pneumatic supply.

8. The PLC analog output card produces a 4-20 milliamp _____ to move the valve from fully open to fully closed.

9. A typical pneumatic actuator will _____ a complete 0-100% over a pneumatic pressure input range of 3-15 psi.

10. As the air pressure _____ to the diaphragm, the force exerted against the spring increases causing the actuator stem to move.

11. In an air-to-open operating condition, the spring forces the _____ closed.

12. An actuator receives a _____ of energy and uses it to move something.

SPEAKING

21. ***Speak about the notable figure who contributed to the advancement of sensors, controllers or actuators. This can be an engineer, inventor, or scientist, for example, Nicola Tesla, Rudolf Kalman, Otto von Guericke. Use the words and useful phrases provided below to help structure your response.***

Useful phrases:

- ✓ *A number of scientists / researchers and their contributions shaped … …*
- ✓ *One notable / key figure in … was … …*
- ✓ *The development was greatly influenced by groundbreaking … …*
- ✓ *Additionally / Furthermore, the work of … …*
- ✓ *One example of a theory by … …*
- ✓ *The inventions / ideas of these inventor / engineer contributed to … …*
- ✓ *In conclusion … …*

22. ***Think about the role of sensors in everyday life, for example, in smart home automation, health monitoring, automobile safety systems etc. Explain the significance of sensors in one of the suggested applications. To help you provide your answer, follow the plan and use the phrases listed below.***

1) First, give the definition of sensor technology, highlight different types of sensors and their functions.

2) Then, provide the examples and functionality of sensors in specific daily application, outline the benefits of integrating sensors, such as energy efficiency, convenience, cost savings and security.

3) Finally, summarize the main points emphasising the significance of sensors in everyday life.

Useful phrases:

- ✓ *To begin with … …*
- ✓ *The significance / importance of sensors … …*
- ✓ *Sensors contribute to … …*
- ✓ *The impact of sensor-enabled … …*
- ✓ *Moreover / Additionally / Furthermore / In addition to that … …*
- ✓ *Moving to the next point … …*
- ✓ *In conclusion / Overall … …*

23. ***Work in pairs. Choose one of the devices: sensor, controller or actuator. Discuss the stages of creation and purpose of the chosen device, as well as challenges and solutions. Use words, useful phrases and questions provided below to help you in your discussion.***

Useful phrases:

- ✓ *Let's start by discussing the origin … …*
- ✓ *The purpose / main function of … …*
- ✓ *The reason for this / main problem is … …*
- ✓ *Just let me explain … …*
- ✓ *I quite / completely / entirely agree … …*
- ✓ *That's true / right … …*
- ✓ *Quite / Exactly / Precisely / Right / Certainly / Definitely … …*

1. How was the sensor / controller / actuator developed?

2. What kind of industrial or technological advancement led to the development of sensor / controller / actuator?

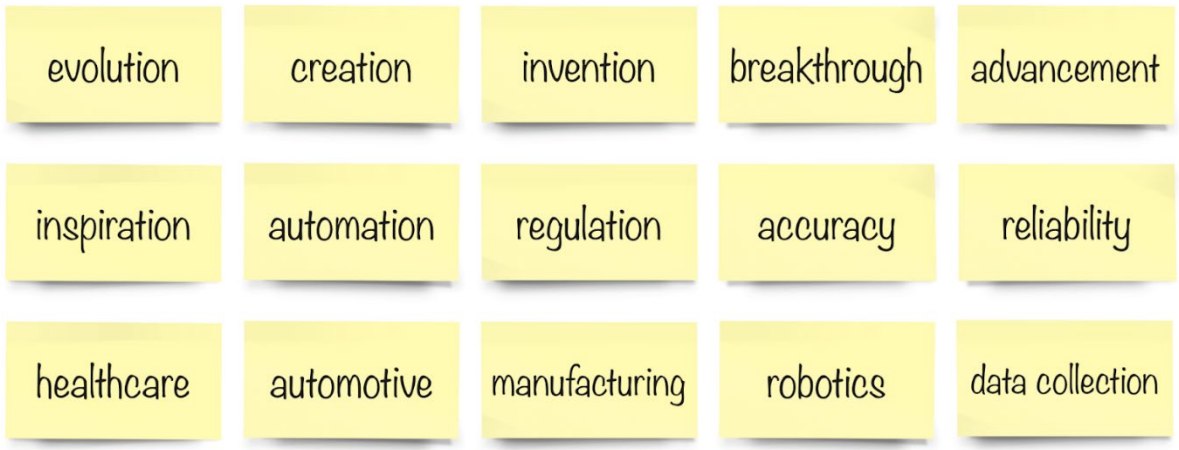
3. Were there any specific needs or problems that inspired the development of sensor / controller / actuator?

4. How does this device contribute to automation and control in different systems and applications?

5. What are the examples of spheres the sensor / controller / actuator is commonly used?

6. What is the common purpose in each sphere of its application?

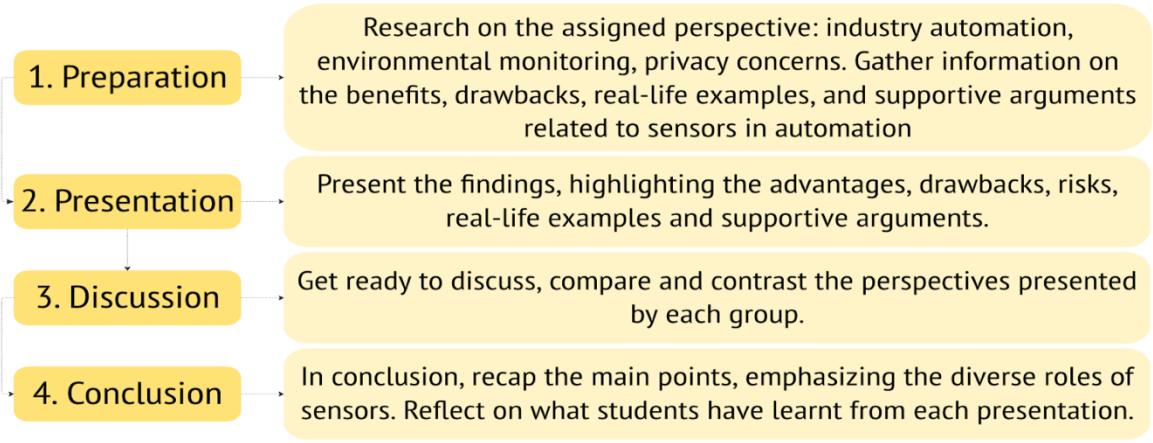
7. Discuss the issues and challenges of sensor / controller / actuator and ways of solving these problems.



24. ***Work in groups. Prepare a presentation about the role of sensors in automation from three different perspectives: industry automation, environment management, privacy concerns. Group A makes a presentation about sensors in industry automation, advantages and potential drawbacks or challenges. Group B prepares a presentation about the role of sensors in environmental monitoring and management, advantages and potential disadvantages and challenges. Group C prepares a presentation about privacy and data security concerns related to the use of sensors in daily life. Each group introduces the use of sensors from their perspective, discusses benefits and drawbacks, provides real-life examples and supportive arguments. Improve your presentation by following the outline and useful phrases provided below.***

Useful phrases for presenting:

- ✓ *In this presentation, we will explore / overview … …*
- ✓ *The purpose / aim of this presentation is to … …*
- ✓ *The focus of our presentation is on … …*
- ✓ *Moving forward to … …*
- ✓ *The main advantages / disadvantages … …*
- ✓ *Another challenge / drawback is … …*
- ✓ *In conclusion / To sum up, our team work provided insight … …*



WRITING

25. ***You are participating in the training session for users who are new to the automation process or technology. Write a manual (150-170 words) with clear step-by-step instructions for setting up and operating a sensor-controlled system, a controller-based automation process, or an actuator-driven mechanism. Include:***

1) introduction;

2) main part: setting up, operating, troubleshooting;

3) conclusion.

Use phrases and keywords in the box below.

inspection	installation	configuration	testing	calibration
monitoring	control	troubleshooting	connectivity	parameters
optimization	accuracy	errors	malfunctions	technical support

Useful phrases:

✓ *To begin with / To start with … …*

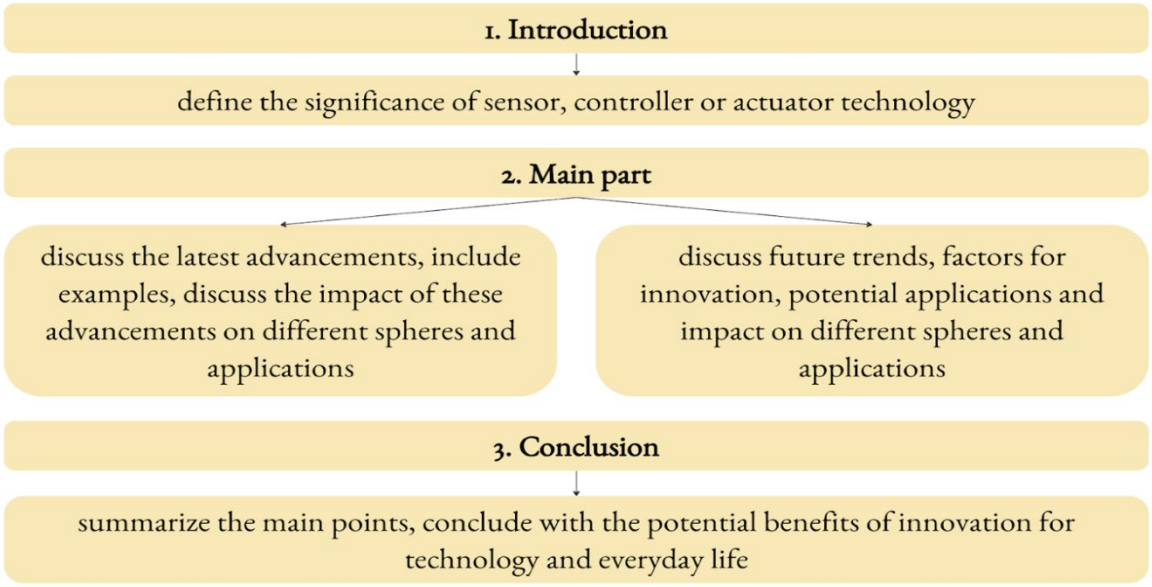
- ✓ *The manual will provide you with step-by-step instructions for …*
- ✓ *Before / First / Then / Next … …*
- ✓ *If you encounter any problems / issues, refer to / consult … …*
- ✓ *Follow the procedure to set up / adjust / calibrate … …*
- ✓ *For example / To illustrate / Such as … …*
- ✓ *In conclusion / To conclude … …*

26. ***You are taking part in a writing contest dedicated to innovations in s c i e n c e a n d t g y . W***

Useful phrases for writing an essay:

- ✓ *This essay / looks into / explores / discusses … …*
- ✓ *In the recent years / lately … …*
- ✓ *Looking ahead, future trends suggest … …*
- ✓ *Another important factor to consider is … …*
- ✓ *As an example / To illustrate this … …*
- ✓ *It is worth noting / highlighting that … …*
- ✓ *In conclusion / To sum up / In closing … …*

sensor	controller	actuator	advancements	innovations
predictions	future trends	implications	consequences	challenges
risks	benefits	opportunities	optimization	efficiency



REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic*** **"Sensors, Actuators, Controllers"** ***using flashcards and then assess comprehension through a Quizlet quiz.***

28. ***Self-assessment test.***

1. Which of the following is a type of motor that converts alternating current into mechanical power?

A. servo motor

B. AC motor

C. comb drive

D. nuclear reactor

2. Which electronic device is used to convert a physical force into an electrical signal?

A. transduction element

B. mediator

C. stepper motor

D. thermostat's thermistor

3. What is used in vacuum pumps, for example in espresso machines?

A. nuclear reactor

B. IoT device

C. hydraulic pressure

D. aircraft flight control system

4. What is known as the device that receives a signal or stimulus and responds to it distinctively?

A. electrical voltage

B. sensing element

C. hydraulic cylinder

D. thermostat's thermistor

5. What is a stepper motor used for?

A. to generate motion

B. to modulate the power

C. to provide feedback

D. to sense

6. What does an IoT device refer to?

A. temperature variations

B. resistive surface

C. nuclear reactor

D. network connectivity

7. Which term is used for the force that presses down on a liquid in a pipe or tube?

A. pneumatic pressure

B. electrical pulse

C. hydraulic pressure

D. electrical voltage

8. What makes up an electronic circuit?

A. resistive surface

B. electronic components

C. stepper motor

D. hydraulic cylinder

9. What types of signals are continuous in time and values?

A. analog signals

B. digital signals

C. electrical pulses

D. signal processing units

10. Which term refers to an electronic component that changes the resistance in its circuit as the temperature changes?

A. thermostat's thermistor

B. temperature variations

C. signal processing unit

D. process control systems

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas and concepts were easy to understand.*	***Yes / No / Partially***

Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I used terms and concepts to discuss sensors, controllers, and actuators. I learned new words and word combinations and used them actively during the lessons.*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic easy and now I can discuss relevant ones.*	***Yes / No / Partially***
Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***
Learning experience	*I think understanding the concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of sensors, controllers, and actuators.*	***Yes / No / Partially***

You didn't choose "Yes" for each statement? Don't worry! Turn

Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*
Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, write down new vocabulary, learn through media, learning from the context. Use can visit, https://youglish.com/ an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*
Listening	*Focus on improving your listening comprehension by watching English-language media.*

Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*
Speaking	*Don't be afraid to make mistakes while speaking. Feel free to express your opinion, even if you think it doesn't correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*
Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience.* *Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

Unit 3

SOFTWARE FOR CONTROL SYSTEMS

LEAD-IN

1

1.	*Sensors*	**A**	To collect data from the environment or system.
2.	*Actuators*	**B**	To process the data collected by sensors and make decisions based on predefined rules or logic to control system behaviour.
3.	*Controllers*	**C**	To generate physical actions or outputs in response to control signals.
4.	*Software algorithms*	**D**	To analyse data from sensors and apply predefined rules or algorithms to determine the actions needed to regulate the system.
5.	*Valves*	**E**	To control the flow rate of liquids within the system, adjusting to meet the requirements specified by the control software.
6.	*Pumps*	**F**	To drive mechanical components within the system, adjusting their speed or position based on control signals from the software.
7.	*Motors*	**G**	To define the logic used by the control software to process data from sensors and determine appropriate system actions.
8.	*Rules of algorithms*	**H**	To regulate the flow of fluids or gases within the system, adjusting to maintain desired conditions based on control signals from the software.

2

READING

4. ***Read the text below. Match choices (A-H) to (1-5). There are three choices you do not need to use. Fill in the table with your answers.***

Control system software is a type of computer program that manages and controls various processes in a system. It is responsible for collecting data, processing it, and generating outputs that can be used to control different aspects of a system. Control systems can range from simple home automation systems to complex industrial processes.

1 _____

Control system software is designed to automate the control of different processes in any given system. It does so by using various inputs, such as temperature sensors, pressure sensors, and other devices. These inputs are then processed according to a set of rules or algorithms that are programmed into the software. The output generated by the control system software can then be used to adjust various components within the system, such as valves, pumps, or motors.

This adjustment helps to maintain the desired level of performance or efficiency within the system.

2 _____

The concept of a control system software often applies to hardware devices with embedded software that manage or control industrial controls, such as a programmable logic control (PLC) device. A software developer specialising in control system software development must think differently than a software developer who performs desktop software development or a software developer who performs enterprise systems integration. This is because of the real time nature of control systems and the industrial environment in which they must operate. There is little tolerance for error; software reliability is crucial.

3 _____

based remote access with the advantages inherent to web application software –

4 _____

One of the primary reasons for adopting an engineering calculation system is to speed up and streamline the design process. To that end, you want to look for a solution that has a familiar user interface and that can crunch large data volumes quickly. MATLAB, Mathcad, and Simulink are among the prominent options available, each offering unique features and benefits tailored to different engineering needs.

5 _____

MATLAB is structured like a series of toolboxes, each with a specialised purpose. For example, there is an aerospace toolbox, a robotics system toolbox, an LTE toolbox, and many others. Each toolbox includes reference examples, but the UI differs slightly from product to product. It’s also difficult to determine which functions are included in a toolbox, or to decide which toolboxes your company really needs.

MATLAB can quickly process large data volumes using a variety of formats, so once you are set up, things will probably move swiftly.

Mathcad comes complete with a series of worksheets, each clearly labelled as to use. PTC also offers some highly specialised worksheets for purchase. In addition, the community can post other worksheets, which are free to download.

Each worksheet provided by PTC uses a similar UI, so it’s easy for engineers to move between worksheets or between Mathcad and Creo and back, for instance. Mathcad is no slouch in the processing speed, either.

’s worksheet system?

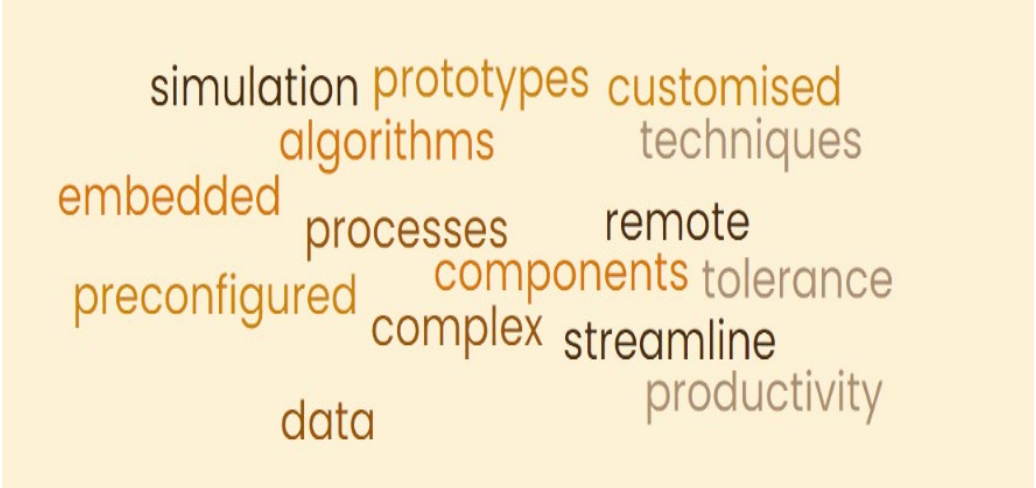
USE of ENGLISH

	Column A		Column B
1.	database	A	concept
2.	continuous	B	equations
3.	software	C	criteria
4.	design	D	storage
5.	tolerance	E	processes
6.	industrial	F	for error
7.	linear	G	access
8.	mathematical	H	development
9.	preconfigured	I	expertise
10.	previous	J	facilities
11.	productivity	K	examples
12.	remote	L	time
13.	reference	M	tracking
14.	streamline	N	blocks
15.	traceability	O	system

8. ***Explain the meanings of the phrases in column A. Then complete the sentences in column B with your ideas.***

	Column A	**Column B**
1.	application coverage analysis	The *application coverage analysis* revealed several areas where user engagement …
2.	complex design sprint	The team completed a *complex design sprint* that allowed them to ...

3.	continuous time	In control theory, *continuous time* models provide a more accurate representation of ...
4.	control loop	The *control loop* is essential for maintaining system ...
5.	engineering calculation system	Implementing an *engineering calculation system* helped the design team streamline their …
6.	enterprise systems integration	Effective *enterprise systems integration* is critical for ensuring that all departments ...
7.	multi-domain dynamical systems	Researchers are focusing on *multi-domain dynamical systems* to better understand ...
8.	natural fit	The new software is a *natural fit* for our existing workflow, enhancing ...
9.	principal interface	The *principal interface* of the robotics system was designed to be user-friendly, allowing ...
10.	robotics system toolbox	The *robotics system toolbox* provides a comprehensive set of tools for …
11.	sampled time	In digital control systems, *sampled time* signals are crucial for ...
12.	software reliability	Investing in thorough testing and quality assurance measures is essential to ensure *software reliability* in ...
13.	to adopt a calculation system	*To adopt a calculation system* that integrates with existing software, the team conducted ...
14.	to process data	The new algorithm is designed *to process data* more efficiently, allowing for ...
15.	tolerance for error	In manufacturing, a *tolerance for error* must be established to balance …


simulation
prototypes
customised
algorithms
techniques
embedded
processes
remote
components
tolerance
preconfigured
complex
streamline
productivity
data

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10. ***Find 15 words related to the topic*** **Software for Control Systems,** ***then choose any three and make sentences.***

q	w	e												
	d													
												t		
					c	u								
			r											

1

1.

	Column A		Column B
1.	range	A	buy
2.	adjust	B	acceptance
3.	maintain	C	adapt
4.	performance	D	distant
5.	tolerance	E	implementation
6.	crucial	F	preserve
7.	consolidation	G	define
8.	demand	H	classify
9.	remote	I	benefit
10.	purpose	J	combination
11.	advantage	K	finish
12.	determine	L	vital
13.	complete	M	objective
14.	principal	N	request
15.	purchase	O	main

12. ***Match the key terms on the topic*** **Software for Control Systems,** ***with their definitions.***

input	processing speed	tolerance for error	prototype	reference example
worksheet	industrial facilities	traceability	sampled time	algorithm
remote access	expertise	calculation	aerospace toolbox	linear system

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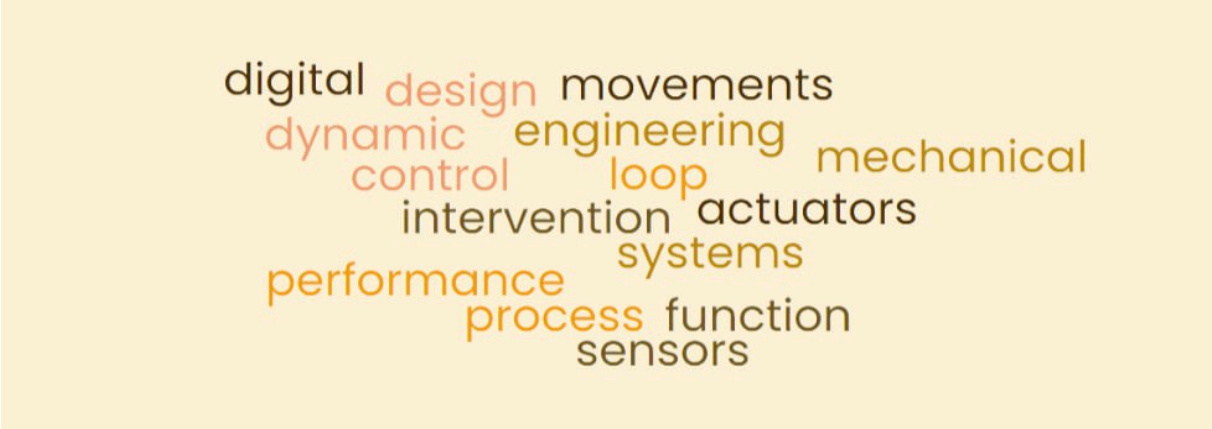

. It's a discipline in engineering that uses control theory to design and develop

Control engineering is key in many user control ***6)*** _____ that range from a simple dishwasher to an airplane. These systems are designed to ***7)*** _____ with minimal or even zero human ***8)*** _____. (E.g., cruise control in auto vehicles).

In practice, "control" refers to the use of tools such as ***9)*** _____ or detectors to measure the results of a ***10)*** _____. The result in turn is used to influence the control ***11)*** _____, and thus the input influences the controlled output – ultimately achieving the desired ***12)*** _____.

Control technology is divided into 3 different types of controls: binary, analog, and ***13)*** _____ controls. Today control engineering mainly refers to binary and digital controls. Binary controls include ***14)*** _____ such as lights, valves, and smaller motors. With binary controls, the control system may be responsible for regulating lighting systems, water flows, or the ***15)*** _____ of vehicle drives. Digital controls are based on the processing of data signals.

,

1.	a) automatic	b) computer	c) pneumatic
2.	a) digital	b) mechanical	c) engineering
3.	a) control	b) network	c) computer
4.	a) algorithm	b) techniques	c) technology
5.	a) input	b) productivity	c) output
6.	a) parts	b) components	c) elements
7.	a) components	b) parts	c) details
8.	a) process	b) performance	c) action
9.	a) network	b) system	c) scale
10.	a) equations	b) calculations	c) examples
11.	a) digital	b) numerical	c) mathematical
12.	a) efficiency	b) input	c) output
13.	a) mathematical	b) chemical	c) physical
14.	a) proportional	b) similar	c) essential
15.	a) simple	b) nonlinear	c) linear

Grammar Box

Future Forms

1

5

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'Grammar: 7 ways to use English tenses to talk about the future' and

1) _____ is used to talk about timetables, and schedules.	*At 8 a.m., the computer control software initiates key operations, performing tasks with precision to maximize productivity.*
2) The phrase "to be going to" or _____ is used to talk about planned appointments.	*On Monday, May 25th we are experimenting with simulated control programs to check their reliability.*
3) _____ is used to talk about future plans that we are not very certain about, on-spot decisions, to express future actions, and events (with words hope, believe, promise, guess, think, etc.).	*Soon, we suppose your company will offer such control software that will include necessary remote management capabilities.*
4) _____ is used to talk about predictions based on some evidence, using the phrase "to be going to", and we use to talk about predictions not based on any evidence.	*Their new robots are going to use advanced algorithms to make predictions. I am not sure but the developers will probably be focused on the early prediction of faults by robots.*
5) _____ is used to talk about the situation that will be in progress at a certain moment in the future.	*Tomorrow at 9 p.m. we will be checking a new software that simulates control systems and works with TecQuipment's controller.*
6) _____ is used to talk about actions that will be finished till a certain time in the future.	*By next Tuesday, the experts will have provided you with the analysis of applied hardware and software solutions and will have summarized the most common block diagrams of control systems.*
7) _____ is used to talk about the duration of some action until a certain time in the future	*By the end of this week, our team will have been working on the design of a new software solution for 2 months.*

1.	*timetable*	**A.**	I have found the mistake! Now we will quickly address it with the help of the control system software.
2.	*fixed plans*	**B.**	To ensure the smooth work of our control system, we will probably have to adopt a highly modular and expandable software architecture.
3.	*on-sport-decision*	**C.**	The certification exam for "Measurement Specialist" starts at

			11:30 a.m. Registration for the exam is open.
4.	*hopes, promises*	**D.**	By the end of the month, we will have been looking for an ICS provider for three weeks.
5.	*predictions based on evidence*	**E.**	Our engineers will have fixed all data entry errors by Wednesday.
6.	*predictions not based on evidence*	**F.**	Steve Woodward, president of Cloud Perspectives, is having some meetings and presentations tomorrow afternoon to discuss the application of function points to the cloud and explore various aspects of the cloud computing ecosystem.
7.	*an action in progress at a stated time in the future*	**G.**	At the next meeting we're going to share our expertise on the matter – to help you make the best decision for your individual use case.
8.	*an action that will be finished by a certain time in the future*	**H.**	As per the agenda, Mr. Willar is going to discuss the latest advancements in control system software during the upcoming presentation.
9.	*a continuous action that will be finished by a certain time in the future*	**I.**	Despite some challenges, I hope we will finish the process of selecting a suitable tool soon.
10.	*"to be going to" for future plans*	**J.**	Tomorrow from 10 to 12 p.m. I will be at the lab and we will be practically developing Simulink models.

1

7

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LISTENING

1


decouple torque
control techniques
pole placement
verify
algorithms
root locus
validate
prerequisite
graphical user interfaces
feedback
a toolbox
field-oriented control

1

9

. **A.** The control system toolbox is a collection of algorithms mainly written as m-files that implement common techniques of design, analysis and modeling of control systems. "Computer Aided Control Systems Design: Control System Toolbox" and put

B. First of all, there are several industries where this machine is still used, either for cost advantages or for simplicity of control.

C. You can operate on them with control system toolbox control design and analysis command.

D. C as a PID controller and f and s as transfer functions.

E. This toolbox is built on the fundamentals of MATLAB to facilitate specialized control systems for engineering tools.

F. You put a few transformations like Park and Clark transformations and some other manipulations to decouple torque and flux so you get the same control methodology of the DC machine.

G. You do not need to use the same type of model objects for each component.

H. In the next lectures, we will show the individual steps from setting up the control loop in Simulink to calculating the controller coefficients and designing the required state observers using the DC machine.

I. Some say the DC machine is no longer state-of-the-art.

J. Therefore, the second prerequisite for this course is to have a basic knowledge of MATLAB Simulink.

K. The phrase "control will be the physics of the 21st century" means that all engineering students should take an introductory course in systems control.

L. To model the entire closed-loop system response from r to *y*, combine *t* with the filter transfer function.

2

0 **1.** It can be seen that _____ and control concepts play an important role in most socio-technical aspects.

2. This basis is the foundation of this course in which complex and extensive _____ and methods are applied with the help of the control system toolbox.

3. In the automotive and aerospace industries an approach to _____ and verifying system development is the so-called *v* model where matworks tools or others are used.

4. Its wide range of services includes classical and modern _____ of control design including root locus, pole placement, and LQG regulator design.

5. Certain graphical user interfaces _____ the typical tasks of control engineering.

6. For example the following control system contains a pre-felta *f*, a plant *g*, and the _____ *c* arranged in a single loop configuration.

7. You can represent each of the components as a _____ object.

8. You can then _____ these elements build models that represent your control system or the control system as a whole.

9. The results _____ loop, t, and tri are also linear model objects.

10. Speaking of control the field-oriented control of the _____ and asynchronous machines is based on the control of the DC machine.

11. Often due to technological circumstances or cost reasons the speed cannot be _____ but the machine still needs to be speed controlled.

12. Thus the state _____ must be designed to estimate the speed that is no longer measured.

SPEAKING

21. ***Think about the procedure of implementing software, potential problems related to this process, and effective solutions. Create a story about a fictional character who tries to implement software for control systems, and faces some challenges. Maintain clarity and creativity. Present your story to the class.***

Useful phrases:

- ✓ *Once upon a time / In a world where … …*
- ✓ *Meet (name of the character) … …*
- ✓ *Suddenly / At that moment … …*
- ✓ *And so / In the end / And thus, the tale of … came to an end … ..*
- ✓ *One of the challenges / obstacles … …*
- ✓ *The most effective solution was / is … …*
- ✓ *In the end / Finally … …*

22. ***Think about your personal experience of implementing control system software or any other type of software. First, consider the challenges faced and solutions or strategies, then, reflect on the lesson learnt from this situation, finally, share your story with the class. Use the phrases and words listed below.***

Useful phrases:

- ✓ *One of the main challenges … …*
- ✓ *Another issue was … …*
- ✓ *One unexpected complication was … …*
- ✓ *To address this issue / challenge … …*
- ✓ *One solution was … …*
- ✓ *In summary / In conclusion … …*
- ✓ *I learnt / This experience taught me … …*

23. ***Work in pairs. Discuss the latest advancements and current trends in control system software, and explain why they are important. Use the questions and useful phrases provided below to help structure your response.***

Useful phrases:

- ✓ *In my opinion / From my perspective … …*
- ✓ *It seems to me that / I think that … …*
- ✓ *As I see it / It appears that … …*
- ✓ *To my mind / As far as I'm concerned … …*
- ✓ *To be honest … …*
- ✓ *From where I stand … …*
- ✓ *In my view … …*

What are the current trends and latest advancements in control system software?

How do these recent advancements and trends impact different industries?

What is the role of AI and IoT in the advancement and evolution of software for control systems?

What is the role of cloud computing in the advancement of software for control systems?

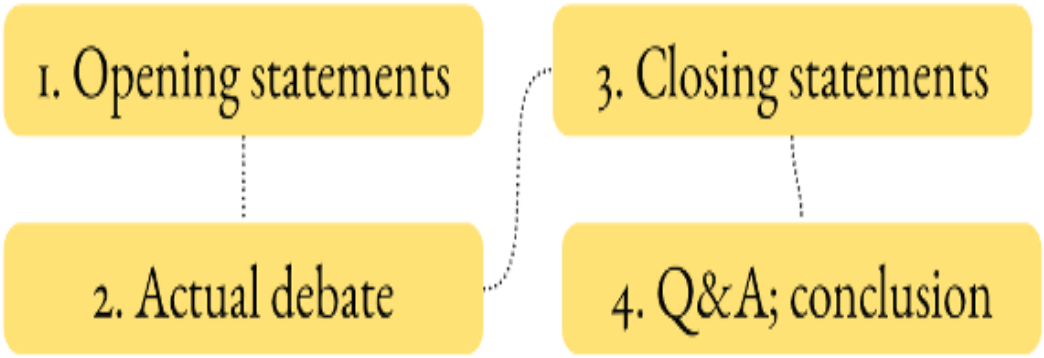
What are the main issues or challenges that may arise when implementing a new software?

What are the ways to overcome the expected challenges?

24. ***Work in groups. Participate in debates on proprietary versus open-source software. Group A's role is to advocate for the proprietary software. Group B's role is to advocate for open-source software. Group C introduces the topic, outlines the procedure of the debate, facilitates and encourages fair discussion ensures equality and summarizes the outcomes. Each group prepares an opening statement, arguments, examples, and visuals to support the arguments, and closing statements.***

Useful expressions for debating:

- ✓ *To start with / I would like to begin by addressing … …*
- ✓ *One key point to consider is … …*
- ✓ *My first / second / next argument is … …*
- ✓ *An argument for/ in favour of / against … …*
- ✓ *There are many examples for / Let me illustrate with an example … …*
- ✓ *I'm afraid I can't quite agree with / It's worth considering the opposing view, which argues that … …*
- ✓ *To sum up, here are the main points / In conclusion, we have presented …*



presents the benefits of proprietary software.

introduces the benefits of open-source software.

acts as a moderator, introduces the topic, establishes the rules and conditions for fair and well-organized openings, ensures that both groups have equal opportunities, and moves the debate to the next stage.

2. ***Actual debate.***

strong arguments highlighting the advantages of proprietary software, streamlined integration with other proprietary services and solutions, higher level of intellectual property protection, etc., gives examples of proprietary software.

presents persuasive arguments supporting the advantages of open-source software, for example, open availability, versatility and flexibility, higher code security, etc., and provides examples of open-source software.

monitors the progression of the debate, maintains order, manages time, and facilitates fair and respectful interactions between the debating teams.

3. ***Closing Statements.***

the main points, reinstates the arguments supporting the positive aspects of proprietary software.

summarizes the key points and points out the advantages of open-source software.

moderates and assists in summarizing important points from both groups, closes the debates, and leads to the Q&A session.

WRITING

25. ***You are invited to participate in an international convention on the e v o t i***

1) introduction, introducing the historical background of software for control systems, the key events, turning points, and significant developments over time;

2) body paragraphs, presenting the evolution of control system software to the present day;

3) conclusion, summarizing the main points.

Useful phrases for writing a report:

- ✓ *The aim / purpose of this report is to outline / present / introduce …*
- ✓ *Let's delve into / focus on … …*
- ✓ *The development of software for control systems … …*
- ✓ *The key events are / include … …*
- ✓ *Over the time, the software has evolved … …*
- ✓ *It is apparent / obvious / clear / evident that … …*
- ✓ *In conclusion / summary … …*

26. You are participating in the intercultural forum for students, where one of the platforms is for sharing real-world applications of software. Research the real-world cases of control system software applications, select the one you f i n d

t h e

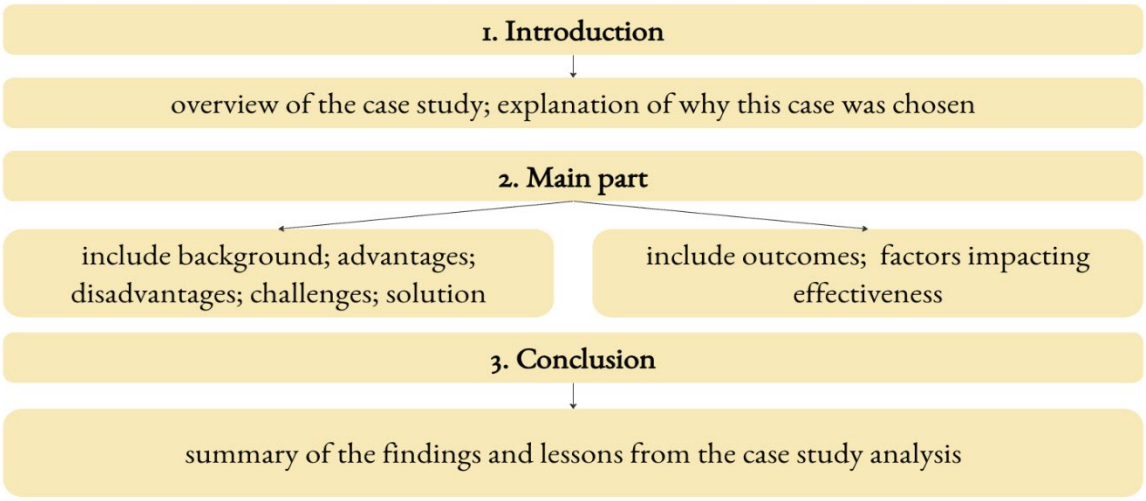
Useful phrases:

- ✓ *The aim / purpose is … …*

m

- ✓ *Then/next … …*
- ✓ *According to … …*
- ✓ *Overall … …*
- ✓ *In brief … …*
- ✓ *To outline … …*
- ✓ *In summary / conclusion … …*

real-world application	advantages	drawbacks	complications	challenges
solutions	monitoring	maintanance	scalability	integration complexity
resistance	adoption	support	compitability	optimization



REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic "Software for Control Systems" using flashcards and then assess comprehension through a Quizlet quiz.***

28. ***Self-assessment test.***

1. Which term defines the system that adjusts variables that control an individual process?

A. control loop

B. embedded software

C. web application software

D. virtual prototypes

2. Which type of computer can receive data through its inputs and send operating instructions through its outputs?

A. programmable logic control

B. preconfigured blocks

C. embedded software

D. diagramming tool

3. Which term is defined as the process of becoming stronger?

A. customised

B. inherent

C. consolidation

D. slightly

4. Which term defines the ability of a system to work properly within a given error range?

A. previous expertise

B. software reliability

C. tolerance for error

D. with minimum effort

5. What is the most accurate definition of web application software?

A. program that is stored on a remote server and delivered over the internet through

B. the system of connected documents on the internet

C. ability to adjust components within the system

D. ability to maintain the desired level of performance

6. What term describes the ability to connect to a central computer using a network?

A. productivity tracking

B. remote access

C. integrated application

D. centralized database storage

7. Which term refers to the process of including something as a part of something bigger?

A. generate

B. customised

C. inherent

D. incorporate

8. What is defined as the natural characteristic of something?

A. slightly

B. inherent

C. swiftly

D. with minimum effort

9. Which word best defines the idiomatic expression ‘like a shot‘?

A. swiftly

B. slightly

C. real-time

D. feature

10. Which word or expression has the same meaning as ‘a little’?

A. volume

B. swiftly

C. slightly

D. inherent

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas, and concepts were easy to understand.*	***Yes / No / Partially***
Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I properly used terms and concepts to talk about software for control systems. I learned new words and word combinations and used them actively during the lessons.*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic is easy and now I can discuss relevant ones.*	***Yes / No / Partially***

Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***
Learning experience	*I think understanding the concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of software for control systems.*	***Yes / No / Partially***

You didn't choose "Yes" for each statement? Don't worry! Turn

Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*

Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look it up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, write down new vocabulary, learn through media, learning from the context. Use can visit, https://youglish.com/ an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*
Listening	*Focus on improving your listening comprehension by watching English-language media.*
Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*
Speaking	*Don't be afraid to make mistakes while speaking. Feel free to express your opinion even if you think it doesn't correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*

Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience. Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

Unit 4

COMPUTER INDUSTRIAL NETWORKS

LEAD-IN

1. ***Match each component (1-8) related to computer industrial networks to its definition (A-H). Discuss your matches with your partner or group members, explaining the role of each component in computer industrial networks.***

1.	*Industrial Control Systems (ICS)*	**A**	The use of networking technologies and protocols in industrial environments to connect various devices and systems, enabling communication and data exchange.
2.	*Industrial Networking*	**B**	The serial communication protocol is commonly used in industrial control systems. It facilitates communication between devices such as PLCs, sensors, and actuators over serial lines.
3.	*Fieldbus Communication*	**C**	The systems that are used to monitor and control industrial processes and infrastructure. They collect real-time data from sensors and other devices, allowing operators to remotely monitor and manage industrial operations.
4.	*Ethernet / IP*	**D**	The systems used in industrial operations to monitor, manage, and control physical processes. They encompass a wide range of devices and software, including sensors, actuators, controllers, and communication networks.
5.	*Modbus*	**E**	The fieldbus communication protocol is used in industrial automation for connecting field devices to control systems. It supports high-speed data exchange and is commonly used in process automation and factory automation applications.

6.	*Profibus*	**F**	The use of Ethernet networking technology in industrial environments. It provides reliable and high-speed communication between devices such as PLCs, HMIs, and industrial switches, supporting various industrial applications.
7.	*Supervisory Control and Data Acquisition (SCADA)*	**G**	The type of industrial networking that enables digital communication between field devices such as sensors, actuators, and controllers. It allows for real-time data exchange and control over a single communication link.
8.	*Industrial Ethernet*	**H**	The communication protocol is widely used in industrial automation. It allows devices to communicate over standard Ethernet networks using the TCP/IP protocol suite.

… …

… …

's evident to me that … …

… …

… …

… …

'm mistaken, but … …

'm not mistaken, … …

1. "Industrial networks are the backbone of modern manufacturing, enabling seamless communication between machines and systems to optimise productivity and efficiency."

2. “Communication protocols like Modbus and Profibus provide the foundation for reliable data exchange in industrial automation, ensuring smooth operation of control systems.”

3. “Ethernet / IP has revolutionised industrial networking, offering unparalleled speed and flexibility for connecting diverse devices and applications in factory environments.”

A technology analyst or industrial networking expert.

“

“

“

“

“

3

READING

4

.

D

Ethernet / IP is a relatively newer protocol in industrial automation, developed in 2001 by Rockwell Automation and the Open DeviceNet Vendor Association (ODVA). Ethernet/IP stands for Ethernet Industrial Protocol, and it is based on the Common Industrial Protocol (CIP), a set of rules and services for data exchange between industrial devices. Ethernet/IP uses the standard Ethernet network and the TCP/IP stack to transmit data and commands, making it compatible with other Ethernet-based protocols and devices. Ethernet/IP is versatile, powerful, and interoperable, but it also has some drawbacks, such as high network load, complex setup, and security risks.

Components of industrial networks:

PLCs (programmable logic controllers): Powerful industrial computers that control and automate various processes in manufacturing.

SCADA (supervisory control and data acquisition): Control systems that gather and analyze real-time data from industrial processes for monitoring and control.

Industrial ethernet switches: Specialised switches for industrial environments that provide reliable and efficient network connectivity.

Industrial Ethernet cabling: Whether it is fiber or copper, the horizontal and structured network cabling, patch panels, and patch cables provide that provide the passive network infrastructure for a reliable system.

1. Industrial control systems encompass the interconnection of diverse electronic devices utilised in factories, process control plants, and automated facilities to oversee and manage manufacturing and other operational functions.

2. A peripheral element found across all industrial control systems is communication networks.

3. Stagnant industrial control systems limit communication equipment use, hampering network performance and operational optimisation.

4. Industrial networking excludes the use of networking technologies and protocols to connect industrial devices and systems for data exchange.

5. Modbus has gained widespread acceptance as a standard communication protocol since its inception in the last six decades.

6. Modbus functions as an open system protocol, adaptable to multiple physical layers, enabling the exchange of information over serial lines among interconnected electronic devices.

7. The Modbus Master initiates information requests, while the Modbus Slaves provide the requested data, utilising a range of transmission mediums beyond RS-232 and RS-485.

8. Profibus: DP (Decentralized Peripherals) focuses on fast, high-volume data exchange between PLCs (Programmable Logic Controllers) and field devices, enhancing efficiency in industrial automation.

9. Created in 2001 through collaboration between Rockwell Automation and ODVA, Ethernet/IP simplifies data exchange among industrial devices using the Common Industrial Protocol (CIP).

10. Ethernet/IP diverges from standard Ethernet networks and TCP/IP stacks for data transmission, presenting drawbacks like high network load, complex setup, and security risks despite its versatility.

11. In industrial networks, there are PLCs, managing manufacturing processes, HMIs, facilitating operator-machine interaction, and SCADA systems, overseeing and analysing real-time data from industrial operations.

12. Industrial Ethernet cabling, comprising specialised components like rugged connectors and shielding, ensures robust and reliable communication within industrial environments, supporting high-speed data transmission and minimising interference.

USE of ENGLISH

	Column A		Column B
1.	automated	A	panels
2.	communication	B	facilities
3.	data	C	instrument
4.	measuring	D	layer
5.	network	E	interface
6.	patch	F	medium
7.	security	G	protocol
8.	physical	H	design
9.	proprietary	I	setup
10.	machine	J	risks
11.	dominant	K	exchange
12.	transmission	L	component
13.	optimise	M	connectivity
14.	complex	N	monitoring
15.	graphical	O	tools

8. ***Explain the meanings of the phrases in column A. Then complete the sentences in column B with your ideas.***

	Column A	**Column B**
1.	advanced information	Industrial networks facilitate the *advanced information* exchange between …
2.	communication networks	By leveraging *communication networks*, companies can increase productivity through …

3.	data acquisition	The new system enhances *data acquisition* by collecting real-time information ...
4.	decentralized field devices	Utilizing *decentralized field devices* allows for greater flexibility in ...
5.	factory automation fields	Advancements in robotics are transforming *factory automation fields*, leading to ...
6.	measuring instrument	The latest *measuring instrument* offers high precision and can ...
7.	network load	To ensure optimal performance, engineers must carefully manage *network load*, preventing ...
8.	process control plant	A *process control plant* monitors and adjusts the operations of ...
9.	proprietary design	The company's new product features a *proprietary design* that gives it a unique ...
10.	standard communication protocol	Adopting a *standard communication protocol* ensures interoperability between …
11.	time-sensitive applications	For *time-sensitive applications*, real-time data processing is critical to ensuring ...
12.	to facilitate data exchange	Cloud-based solutions are increasingly popular *to facilitate data exchange* between ...
13.	unidirectional control	The system employs *unidirectional control* to ensure that commands ...
14.	wireless networking technologies	With the rise of *wireless networking technologies*, manufacturers can now deploy ...
15.	serial lines	Older machines often rely on *serial lines* for communication, which can limit ...


devices
development
complex
various
machinery
compatible
equipment
connectivity
optimise
infrastructure
services
protocols
exchange
real-time
transmission

1

1.

	Column A		Column B
1.	dominant	**A**	*improve*
2.	include	**B**	*ease*
3.	increase	**C**	*prevalent*
4.	optimise	**D**	*exclusive*
5.	commonly	**E**	*equip*
6.	facilitate	**F**	*actual*
7.	wireless	**G**	*consist of*
8.	proprietary	**H**	*cooperative*
9.	supply	**I**	*usually*
10.	drawback	**J**	*convey*
11.	compatible	**K**	*extend*
12.	real time	**L**	*settled*
13.	deterministic	**M**	*switch*
14.	transmit	**N**	*disadvantage*
15.	exchange	**O**	*cordless*

protocol | facilities | authentication | relay | patch panel
compatible | interface | medium | encoder | field bus
performance | machinery | valve | processing power | network load

, above all the perceived performance seen by the users. The keywords here are “perceived performance”. Also, notice that protocols are nowhere to be found in

Here are a few examples of industrial ***1)*** _____ the challenges and benefits they offer for industrial ***2)*** _____ systems. From the oil and gas industry to pharmaceuticals, automotive, and food and beverage, these are real-life ***3)*** _____

scenarios that have been actualized. From streamlined network infrastructure to improved scalability and ***4)*** _____, modern industrial network best practices are revolutionizing the way industries operate.

Automotive manufacturing: Industrial networks are widely used in automotive manufacturing plants to integrate different systems and ***5)*** _____, such as robots, ***6)*** _____, and quality control systems. It ensures seamless communication and coordination between these components, improving overall efficiency, and ***7)*** _____.

Food and beverage industry: Industrial networks are implemented in food and beverage production facilities to connect various ***8)*** _____, such as mixing machines, packaging lines, and quality inspection systems. This enables real-time monitoring and control, enhancing product quality, and ***9)*** _____.

Oil and gas sector: Industrial networks are utilized in oil and gas refineries and production facilities to integrate critical systems, including pumps, ***10)*** _____, and safety devices. It enables efficient monitoring, control, and optimization of these processes, ensuring safe and reliable operations.

p
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d

1.	a) *networks*	b) *production*	c) *productivity*
2.	a) *production*	b) *automation*	c) *operation*
3.	a) *design*	b) *situations*	c) *environment*
4.	a) *effectiveness*	b) *efficiency*	c) *security*
5.	a) *machines*	b) *devices*	c) *mechanisms*
6.	a) *conveyors*	b) *machines*	c) *computers*
7.	a) *maintenance*	b) *effectiveness*	c) *productivity*
8.	a) *devices*	b) *equipment*	c) *machines*
9.	a) *quantity*	b) *price*	c) *safety*
10.	a) *bearings*	b) *valves*	c) *gears*
11.	a) *virus*	b) *program*	c) *software*
12.	a) *machinery*	b) *equipment*	c) *machines*
13.	a) *characteristics*	b) *properties*	c) *effects*
14.	a) *integration*	b) *application*	c) *operation*
15.	a) *environment*	b) *sphere*	c) *field*

Grammar Box

Passive Forms

1

5

1) ***Present / Past Simple Passive*** is used to talk about regular activities, permanent states, timetables, and schedules.	*Industrial networks are built from a combination of Ethernet and IP networks and at least one real-time network or fieldbus.*
2) ***Present Simple / Continuous Passive*** is used to talk about the actions being performed at the moment.	*The overview of some of the more common industrial network designs and architectures is being provided by the professor now.*
3) ***Present Perfect / Continuous*** is used to express the recent action, or past action when time is not stated.	*Since 1970 a variety of specialized "fieldbus" protocols have been used by Industrial networks to accomplish specific tasks, often with careful*

h

e

	attention to synchronization and real-time operation.
4) ***Past Simple / Continuous Passive*** is used to express the actions that happened at a stated time in the past, and ***Past Perfect / Simple*** is used to indicate an action that had happened before another past one.	*In 1968, the concept of the programmable logic controller was invented by the company Modicon.*
5) ***Future Simple / Present Continuous*** is used to talk about plans which we are not very certain about, on-spot decisions, to express future actions, and events (with words hope, believe, expect, promise, guess, think, etc.).	*We hope that with new controllers, the response times of systems will be improved, allowing for cost reduction.*
6) ***Passive Infinitive / Gerund*** is used after modal verbs (may, should, could, etc.) to indicate what is possible or what is correct.	*As clean enclave boundaries begin to overlap the use of "business" network protocols to transport fieldbus protocols should be avoided unless necessary.*
7) ***Passive Infinitive / Gerund*** is used to indicate a past action. The time it refers to is always before the time the main verb of the sentence refers to. It can be both in the active voice and the passive voice.	*The control system software displayed no indications of having received prior alerts.*
Note! When one thing or person causes another thing or person to do something, a causative form is used, that is 'have' or 'get' + Past Participle. Example: I want to get my lab done by my friend.	

16. ***Match the rule of using Passive Voice (1-10) with the examples of their use in the sentences (A-J).***

			.

Let’s go back in time: we are not going to talk about the different industrial revolutions, but our story begins at the start of the 70s. At the time, there was no Ethernet network, OSI model, or even IT. Industrial production systems relied on physical mechanisms using pneumatic or electrical signals**.** The first

principles of automation **1)** _____ (PRESENT) in the 1970s, and the integration of the first intelligent equipment started: the programmable logic controllers (PLC) **2)** _____ (LAUNCH). This equipment allows resources **3)** _____ (POOL), as several electrical inputs and outputs can **4)** _____ (MANAGED) by a PLC, and therefore the management of processes **5)** _____ (CENTRALIZED). communications modules **6)** _____ also (INCORPORATE) by PLCs, and this led to the appearance of the first bus networks in industrial systems, using serial communications protocols.

The 1990s brought the democratization of the TCP/IP model and the integration of 'traditional' IT into industrial environments: no more need for proprietary equipment, SCADA software can now **7)** _____ (INSTALL) on conventional systems but these computers still need to be able to communicate with the PLCs! Serial network cards exist, but industrial protocols are beginning to adapt to operate on a conventional Ethernet network. Master controllers gradually **8)** _____ (REPLACE) to enable them to use TCP/IP protocols on

the main network, while continuing to have serial network cards for field equipment.

https://www.riskinsight-wavestone.com/en/2024/02/plc-network-the-history-of-industrial-systems-facing-up-to-the-challenges-of-the-future/

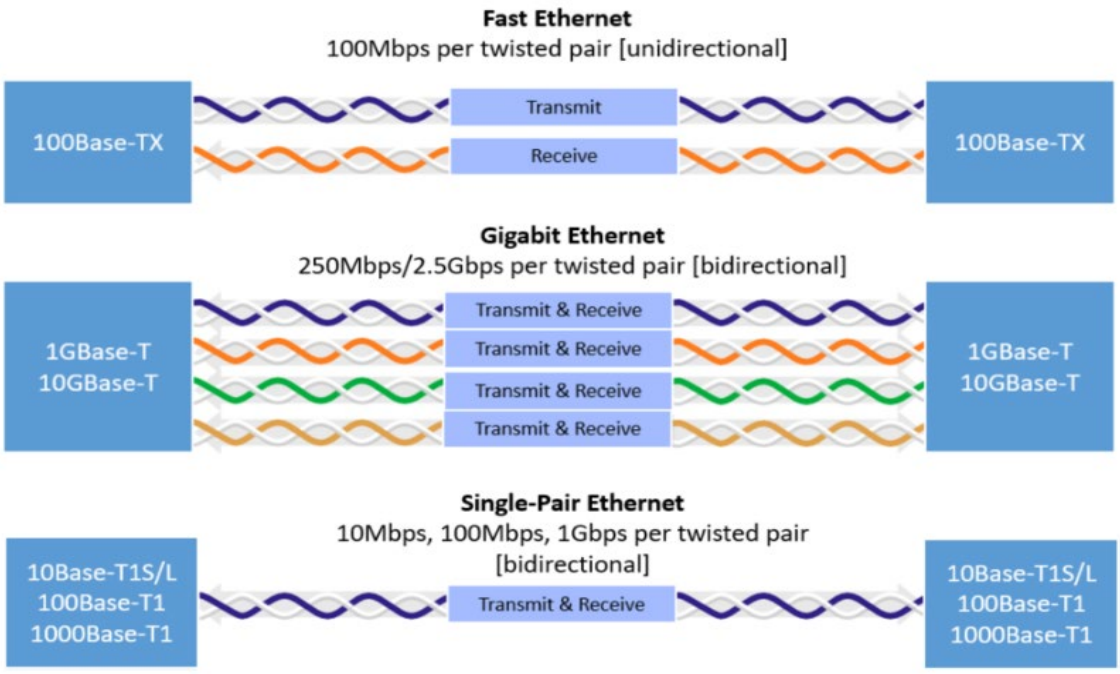
LISTENING

1

8.

tremendously	topologies	comprehensive	scalability
multi-drop configuration	single-pair	learning curve	eliminate
communication protocol	physical protocol	communication rate	carry over

"The Benefits of Using Single Pair Ethernet for Industrial Automation".



1. A single pair of wires is used for both data and power in single-pair Ethernet (SPE).

2. Establishing a PROFINET communication network using any of the three physical Ethernet protocols is not possible.

3. Using different infrastructures for network devices and cables results in more parts to stock, a longer learning curve for maintenance personnel, and a longer design time for new and upgraded installations.

4. SPE is designed exclusively for industrial automation.

5. SPE multi-drop configurations allow for the daisy chaining of up to eight different devices.

6. Because SPE networks enable simplicity, space savings, and ease of installation in industrial automation, quick-connect cables eliminate the need for cable glands, sensor housing removal, and screw terminations.

7. Despite the compact design and simplicity of Single-Pair Ethernet (SPE), manufacturing space must be carefully managed to accommodate SPE's infrastructure.

8. SPE needs specialized software to function in an industrial environment.

9. Traditional industrial Ethernet protocols cannot communicate as quickly as Single-Pair Ethernet (SPE).

10. The 1000BASE-T1 version of Single-Pair Ethernet (SPE), defined by IEEE 802.3bp, supports cable lengths up to 40 meters with a data rate of 1Gbps, making it perfect for high-communication devices like robots that need the compactness of SPE.

11. SPE cables are less durable in harsh industrial environments.

12. Single-Pair Ethernet (SPE) isn't well-defined by standards, causing problems with compatibility between different manufacturers' devices in industrial automation.

1. You are probably familiar with standard traditional Ethernet Cat6 cables, which use 4 pairs of _____ for communication, and perhaps industrial Ethernet cables which use 2 pairs of wires.

2. Whether it is traditional Ethernet, industrial Ethernet, or single-pair Ethernet, all are physical _____ that can transfer data using the same types of Ethernet communication.

3. Single-pair Ethernet networks require only a single cable for both data and _____ , making the overall cabling infrastructure more straightforward and less bulky.

4. Since power and communication signals can be carried over the same cable to each sensor, the number of cables that need to be _____ is cut in half.

5. Only a single control panel is required to supply the necessary sensor power and make the communication _____ at a common SPE switch.

6. Multi-drop _____ can also greatly reduce the number of long runs of cable back to a central control cabinet by allowing up to 8 sensors to be connected in a daisy chain fashion.

7. Power and data are delivered to the devices over a single cable using familiar 4-pin M8 _____ or 6-pin M12 connectors.

8. This can reduce the _____ on cable trays, allowing for less expensive support structures.

9. SPE can reach longer distances than traditional Ethernet without the need for additional repeaters or _____ , which is useful in expansive industrial environments.

10. This version of SPE will become tremendously useful for devices such as robots that require a high rate of communication and the _____ and compactness of SPE.

SPEAKING

21. ***Give a brief explanation of computer industrial networks in layman's terms. Define and explain the concept using easy-to-understand terms. Use everyday examples and analogies to make the concept understandable, adding some elements of fun, like jokes or anecdotes. Use the phrases provided below to help structure your response.***

Useful phrases:

- ✓ *Today, we're going to talk about … …*
- ✓ *A computer industrial network is like … …*
- ✓ *Imagine that … …*
- ✓ *First / Then / Next … …*
- ✓ *Now, think about / Let's think about … …*
- ✓ *Another way to look at … …*
- ✓ *So, in a nutshell, / in general … …*

22. ***Speak about the effectiveness of different network protocols. To help you provide your answer, follow the plan as your guide and use the phrases listed below:***

1) first, introduce the types of network protocols;

2) then, present the arguments supporting the effectiveness of different protocols, comparing and contrasting them;

3) finally, summarize the main points.

Useful phrases:

- ✓ *I'd like to start by introducing … …*
- ✓ *Protocols play a crucial / paramount /pivotal role in … …*
- ✓ *Network protocols are essential / important … …*
- ✓ *There are various types of protocols … …*
- ✓ *It is commonly used in … …*
- ✓ *Its role is to … …*
- ✓ *To sum it up / To summarize the main points … …*

23. ***Work in pairs. Brainstorm common problems related to computer industrial networks, and discuss the solutions. Present the problems and explain the solutions to them step by step in logical order. Discuss why your strategy is appropriate for solving each specific problem. Use the words and phrases provided below to help you in your discussion.***

Useful phrases:

- ✓ *One common problem is … …*
- ✓ *Another issue is … …*
- ✓ *First / Then / Similarly … …*
- ✓ *Next, I propose … …*
- ✓ *Let me clarify my reasoning … …*
- ✓ *I believe this strategy is suitable / appropriate because … …*
- ✓ *This method increases the effectiveness of the solution because … …*

24. ***Work in groups. Create a list of questions for a quiz show about computer industrial networks and take turns to host it and present your questions in three themed rounds. Group A creates a set of questions for the first round, focused on the network protocols and standards. Group B prepares a set of questions about the security in computer industrial networks. Group C creates a set of questions for a round focused on data management and analytics in computer industrial networks. Use the phrases provided below.***

Useful phrases:

- ✓ *Our group / team created a set of questions focused on … …*
- ✓ *The aim is to … …*
- ✓ *Get ready to answer the questions … …*
- ✓ *Get ready to explore / dive in … …*
- ✓ *Take your time … …*

- ✓ *We hope you enjoyed the experience / participation … …*
- ✓ *To summarize / conclude … …*

WRITING

25. ***You are invited to participate in an international students' conference dedicated to computer networks. Write your report (160-180 words) 'Strategies for optimizing computer industrial networks performance', maintaining the structure:***

1) an introduction, stating the importance of computer industrial networks and the need for optimization;

2) a body paragraph, exploring the optimization measurement tools, factors that impact optimization, optimization techniques and instruments, providing examples and supporting evidence;

3) a conclusion, summarising the main points and emphasising the importance of network optimization in industrial settings. Use phrases and keywords provided below.

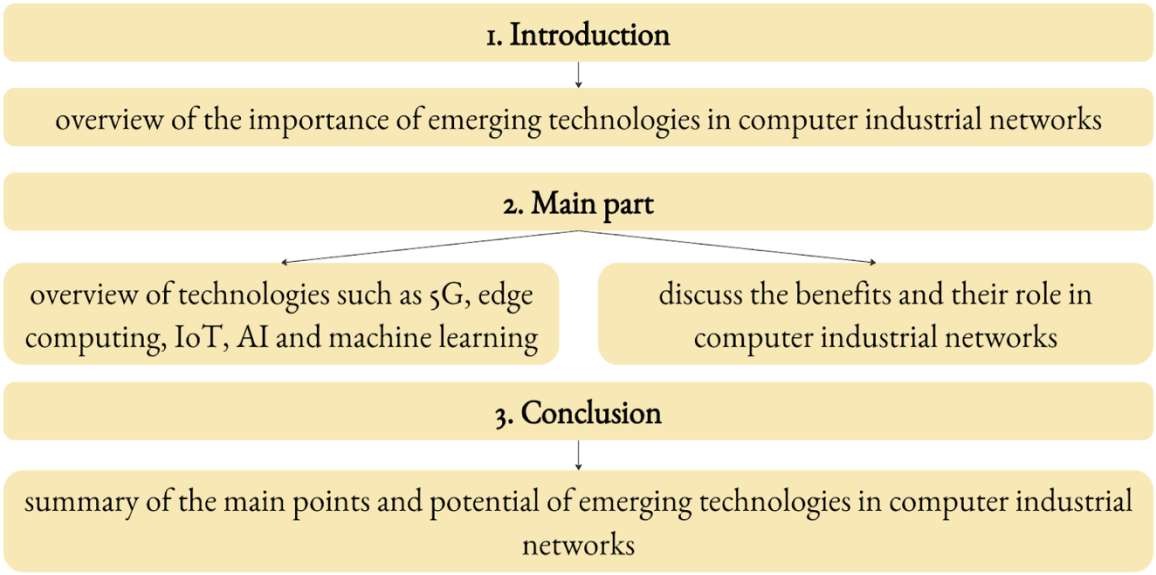
Useful phrases for writing a report:

- ✓ *The aim / purpose of this report is to outline / present / discuss … …*
- ✓ *The objective is to … …*
- ✓ *Let's explore / examine / Now let's focus on … …*
- ✓ *It is apparent / obvious / clear / evident that … …*
- ✓ *In comparison / in contrast … …*
- ✓ *As a consequence / result of … …*
- ✓ *In conclusion / summary we studied … …*

26. ***Write a post for your blog (160-180 words) about the emerging technologies in computer industrial networks. Use the phrases and follow the outline provided below, including an introduction, a main part, and a conclusion. Pay attention to clarity, coherence, and accuracy in your writing.***

Useful phrases:

- ✓ *In this blog post, we'll study … …*
- ✓ *Imagine what it would be like … …*
- ✓ *First of all / For starters … …*
- ✓ *Similarly / In other words … ….*
- ✓ *For what it's worth / Basically … …*
- ✓ *Let me give you some examples … …*
- ✓ *Let's rewind / To sum up … …*



REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic*** **"Computer Industrial Networks"** ***using flashcards and then assess comprehension through a Quizlet quiz.***

28. ***Self-assessment test.***

1. Which term defines the procedure of proving that something is real or true?

A. authentication

B. data acquisition

C. data exchange

D. drawback

2. Which term describes information that is ahead in the development?

A. medium

B. versatile

C. advanced information

D. compatible

3. Which term is defined as something existing in fact, although not necessarily intended?

A. de facto

B. significantly

C. versatile

D. unidirectional control

4. What is known as a device that reacts to a small change in an electrical current by moving switches or other devices in an electrical circuit?

A. fibre

B. equipment

C. encoder

D. relay

5. What term refers to the rules for exchanging information between the components, enabling communication?

A. unidirectional control

B. wireless networking technologies

C. communication protocol

D. authentication

6. What term defines something that connects devices to an Ethernet or other type of network?

A. automated facilities

B. network cabling

C. communication protocol

D. process control plant

7. Which technology transfers data by dividing it into a 4-layer procedure?

A. versatile

B. TCP / IP

C. encoder

D. communication networks

8. What does TCP stand for in networking?

A. Transmission Control Protocol

B. Time-consuming protocol

C. Transmission Command Process

D. Transitive Control Procedure

9. Which term commonly refers to the ability to be used for multiple purposes?

A. significantly

B. drawback

C. optimise

D. versatile

10. What word can be defined as a negative of a product or situation?

A. drawback

B. interoperable

C. de facto

D. security risks

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas, and concepts were easy to understand.*	***Yes / No / Partially***
Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I properly used terms and concepts to talk about computer industrial networks. I learned new words and word combinations and used them actively during the lessons.*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic is easy and now I can discuss relevant ones.*	***Yes / No / Partially***

Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***
Learning experience	*I think understanding mathematical concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of computer industrial networks.*	***Yes / No / Partially***

You didn't choose "Yes" for each statement? Don't worry! Turn

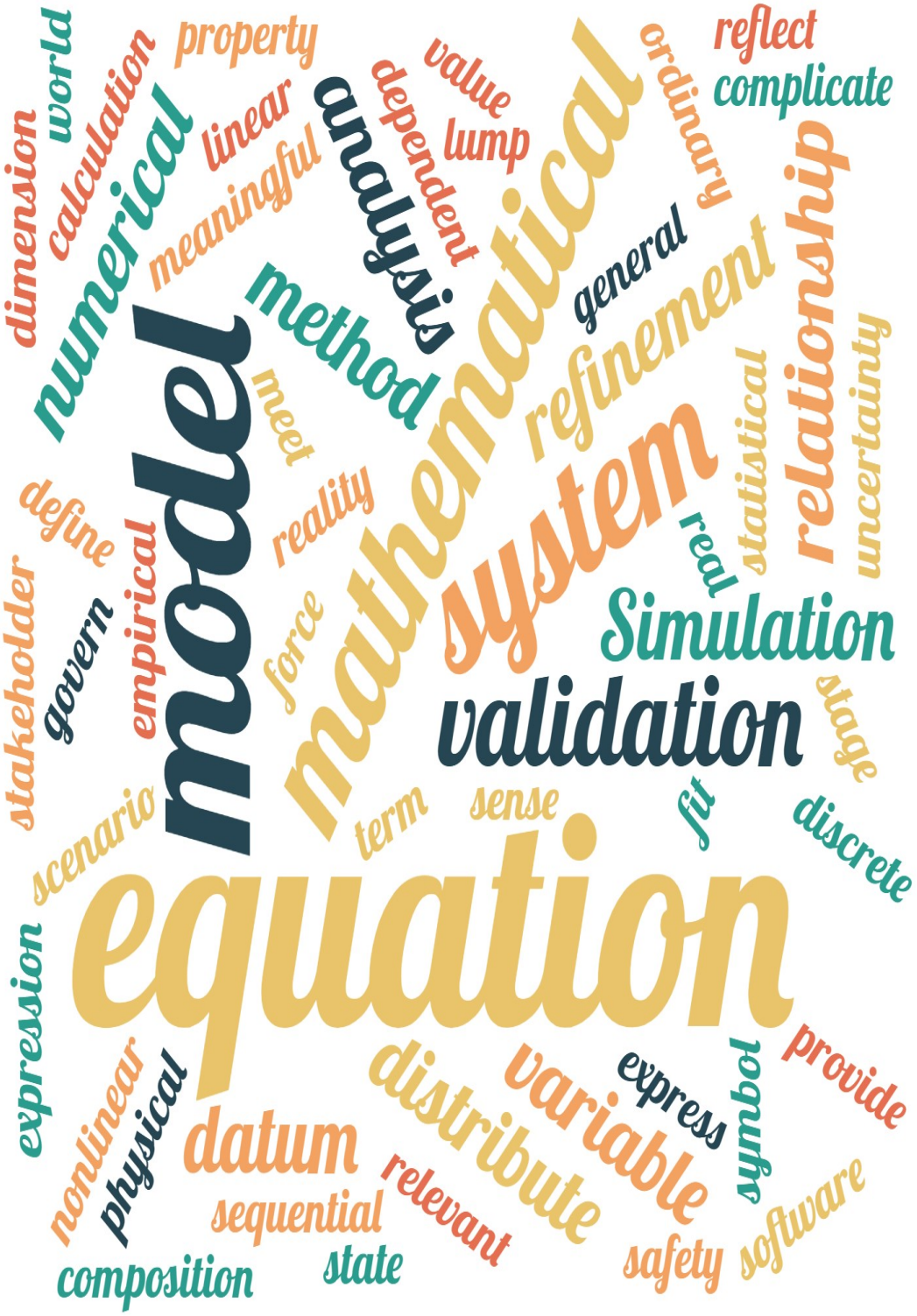
Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*

Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, write down new vocabulary, learn through media, learning from the context. Use can visit,* ***https://youglish.com/*** *an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*
Listening	*Focus on improving your listening comprehension by watching English-language media.*
Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*
Speaking	*Don't be afraid to make mistakes while speaking. Feel free to express your opinion even if you think it doesn't correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*

Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience. Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

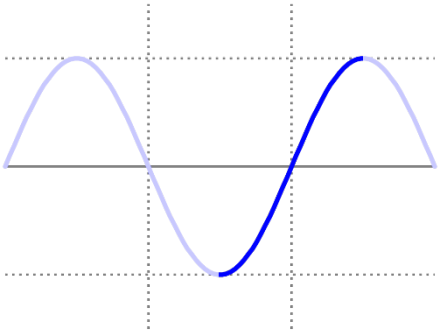
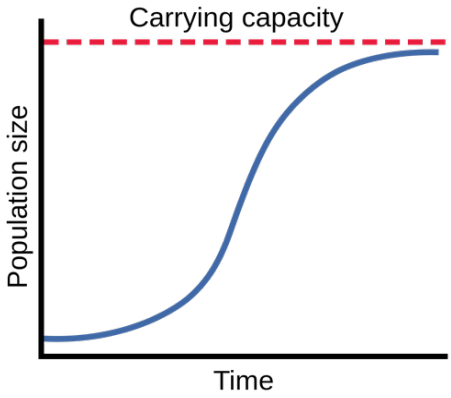
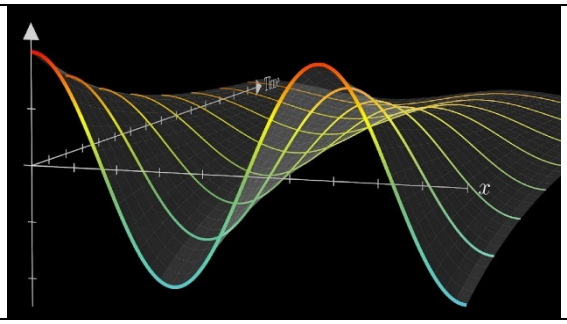
Unit 5

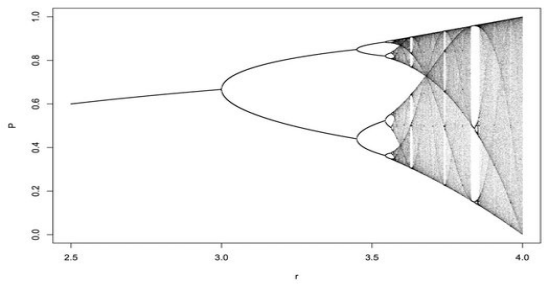
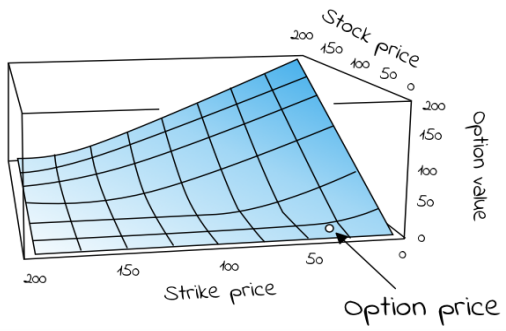
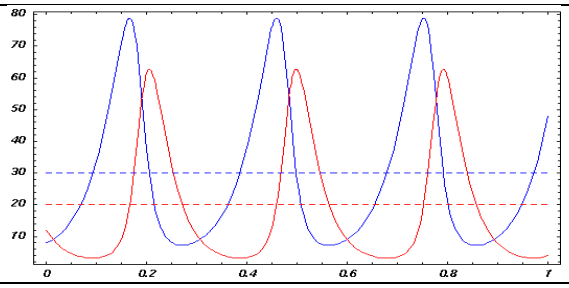
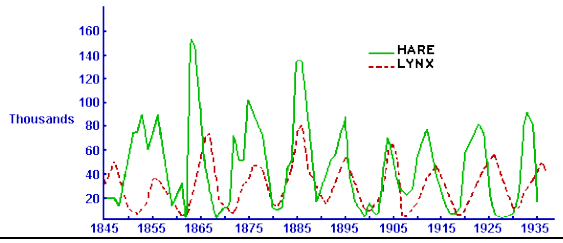
MATHEMATICAL MODELING



LEAD-IN

1. ***Look at the provided pictures (1-8) representing famous mathematical models or concepts. Match each picture to its corresponding mathematical model (A-H) or concept. Discuss your matches with your partner and explain your reasoning.***

1.		**A**	Thermodynamics. Heat diffusion equation, a partial differential equation that describes how heat spreads through a material over time.
2.		**B**	Ecology. Predator-prey model, a mathematical model that describes the interactions between predator and prey populations in an ecosystem.
3.		**C**	Trigonometric functions. Sine wave, a periodic oscillation represented by a smooth, repetitive curve.
4.		**D**	Population dynamics. Logistic map, a mathematical model that describes population growth in discrete time, often used to explore chaotic behaviour.

5.		**E**	Population dynamics. Lotka-Volterra equations, a set of differential equations used to model the dynamics of biological predator-prey interactions.
6.		**F**	Population dynamics. a logistic growth curve is a model that describes how a population's growth rate slows down as it approaches its carrying capacity.
7.		**G**	Financial mathematics. The Black-Scholes model is a mathematical model used to calculate the theoretical price of financial options.
8.		**H**	Chaos theory. Lorenz attractor is a mathematical model that illustrates the concept of deterministic chaos and the sensitive dependence on initial conditions.

2

…

…

…

’s widely acknowledged that … …

…

’s universally recognised that … …

’s no question that … …

- ✓ *Honestly, … …*

“

2

3

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8

3

READING

.

Although the terms ‘model’ and ‘modeling’ may seem common terms, they

,

The stages of mathematical modeling can be summarised as follows:

• Problem formulation: This stage involves defining the problem to be solved and identifying the variables that are relevant to the problem.

• Model development: This stage involves constructing a mathematical model of the system, which typically involves developing equations that represent the relationships between the variables. The model may be developed based on first principles or on empirical data.

• Model analysis: This stage involves analyzing the mathematical model to gain insights into the behavior of the system. This may involve solving the equations analytically or using numerical methods to simulate the behavior of the system.

• Model validation: This stage involves testing the model against real-world data to determine how well it predicts the behavior of the system.

• Model refinement: Based on the results of the validation stage, the model may need to be refined by adjusting the equations or variables used in the model.

• Model communication: This stage involves presenting the results of the modeling process in a clear and understandable way, often to stakeholders who may not have a strong background in mathematics.

It is worth noting that these stages are not always sequential or discrete.

What does ‘modeling’ allude to?

’s attributes or structure

’s output

’s complexity

USE of ENGLISH

	Column A		Column B
1.	common	A	variable
2.	dependent	B	symbols
3.	differential	C	system
4.	empirical	D	refinement
5.	mathematical	E	calculations
6.	meaningful	F	data
7.	safety	G	scenario
8.	physical	H	terms
9.	difficult	I	influences
10.	spatially	J	equations
11.	real-world	K	standards
12.	numerical	L	expression
13.	model	M	functions
14.	forcing	N	distributed
15.	external	O	method

8

	Column A	Column B
1.	algebraic relationship	The *algebraic relationship* between the variables was used to …
2.	broadly defined	The term "AI" is *broadly defined* as …
3.	distinct values	The dataset contained *distinct values* that allowed the researchers to …

4.	distributed parameter system	In a *distributed parameter system*, the physical properties …
5.	functional relationship	A *functional relationship* between input and output variables can help predict system behavior when …
6.	independent variable	In the experiment, the *independent variable* was …
7.	linear differential equations	*Linear differential equations* are often used in engineering to …
8.	lumped parameter systems	In *lumped parameter systems*, spatial variations are ignored, letting engineers to …
9.	mathematical representation	The *mathematical representation* of the physical process can help the team to understand …
10.	nonlinear differential equations	*Nonlinear differential equations* can model complex behaviors, such as …
11.	meet the safety standards	To *meet the safety standards* the new system should be …
12.	partial differential equations	*Partial differential equations* are used in fields like …
13.	to provide insight	The data analysis was conducted *to provide insight* into the factors influencing …
14.	to represent the realities	The model was adjusted to better *represent the realities* of …
15.	system's properties	Understanding the *system's properties* is essential …


spatially
relationships
superposition
behaviour
equations
expresses
evaluating
analytically
meaningful
predictions
independent
representation
dimensions
variables
concepts

s	s	d												
c														
												c		
					p	h								

1

1.

	Column A		Column B
1.	fundamental	A	confirmation
2.	appreciation	B	quantity
3.	common	C	measurements
4.	number	D	basic
5.	relationship	E	connection
6.	dimensions	F	practical
7.	simple	G	ordinary
8.	real-world	H	rule
9.	observe	I	foresee
10.	construct	J	uncomplicated
11.	validation	K	uninterrupted
12.	predict	L	clear
13.	understandable	M	watch
14.	govern	N	recognition
15.	continuous	O	create

mathematical expression
stakeholder
validation
properties
variable
refinement
superposition
equation
discrete model
physical system
concept
calculation
functional relationship
dimensions
algebraic relationship

At its core, mathematical modeling is a ***1)*** _____ of abstracting complex real-world situations into a simplified mathematical ***2)*** _____. It involves several fundamental components:

and reliability. Validation involves comparing the model's predictions to real-

While mathematical ***10)*** _____ is a powerful tool, it comes with challenges and limitations:

8

1

1

1

4

)

1.	a) field	b) science	c) modeling
2.	a) investigation	b) research	c) experiments
3.	a) technology	b) manufacturing	c) science
4.	a) science	b) engineering	c) mathematics
5.	a) simulate	b) predict	c) create
6.	a) mathematical	b) different	c) structural
7.	a) hydraulic	b) mechanical	c) chemical
8.	a) information	b) numbers	c) data
9.	a) scheme	b) system	c) structure
10.	a) mathematical	b) foreign	c) native
11.	a) techniques	b) sciences	c) technologies
12.	a) surroundings	b) nature	c) environment
13.	a) essential	b) simulation	c) production
14.	a) area	b) field	c) branch
15.	a) activity	b) productivity	c) science

Grammar Box

Conditionals

1

5

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W

a

t

"If clause"	***Main clause***	
"If clause"	***Main clause***	
	- any modal verb - imperative	
	- any modal verb - imperative	*process hasn't been approved,*
"*if*".		
"If clause"		
"If clause"		

LISTENING

1

simplifications	stirred tank heater	energy balance	flow rate
accumulation	derivitave	constant rate	restate
thermodynamics	heating coil	outlet stream	inlet

1

9

. **A**

B

. **C**

. **D**

. **E**

.

"Mathematical Modeling: Energy Balances" ***and put the sentences in the***

F

. G

. H

. I

: J

: K

. L

2

0 1. The _____ of the liquid inside the stirred tank heater is volume V.

. 2. So if we look at our mass balance first, we recognize the fact that there is no generation, no _____ going on, and there's no chemical reaction occurring.

3. So what that means is the fact that the _____ in this mass balance is zero.

4. So now that we've shown that our mass balance doesn't provide any real fruitful information, we can now go to our energy balance, which is that accumulation of energy _____ in minus out, energy in minus energy out, plus energy from a chemical reaction, plus energy from the surroundings.

5. So for example, for an exothermic chemical reaction, the value for this term should be a positive because the temperature of the process inside the system is going to _____.

6. So recall from thermodynamics that we can get some idea of an energy per _____ basis by the use of enthalpy, h.

7. Our end term will be w times the inlet enthalpy of the _____ minus the outlet stream, which is w.

8. For our _____ volume is the inside of the stirred tank heater.

9. So d energy dt inside this derivative, what we need to find is the _____ of energy that is inside the tank that the fluid has.

10. With this _____ we can restate our energy balance as d rho V h tank dt equals the right-hand side.

11. The derivative will now become rho V Cp _____ T, which is the temperature inside the tank.

12. We can do a very similar _____ for the outlet stream, which is at temperature T, and then we add the q term.

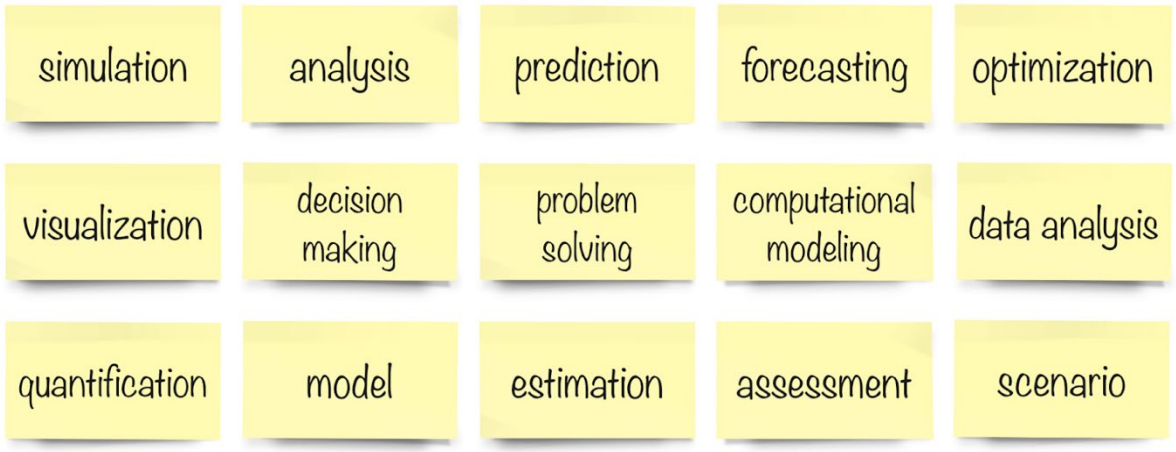
SPEAKING

21. ***Think about the various spheres of applications and purposes for mathematical modeling, for example, simulation, analysis, visualization, etc. Use the words and useful phrases provided below to help structure your response.***

Useful phrases:

- ✓ *To begin with … …*
- ✓ *Mathematical modeling provides / serves … …*
- ✓ *Mathematical modelling is valuable in … …*
- ✓ *Focusing our attention on … …*
- ✓ *Shifting our focus to … …*
- ✓ *Additionally / Furthermore / Moreover … …*

✓ *In conclusion … ….*



22. ***Think about the mathematical modeling cycle for a certain process,***

f

o ***Research and present the modeling cycle for the chosen process, include***

examples and visuals in your presentation, and use the phrases provided below.

Useful phrases:

e ✓ *To begin with … …*

x ✓ *Firstly, let me introduce / explain … …*

a ✓ *Then / Next / Moving forward … …*

m ✓ *Let's examine / look at the examples of … …*

p ✓ *Another step / stage / component / example of … …*

l ✓ *Finally … …*

e ✓ *In conclusion … …*

,

a

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e

p

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a

t

23. ***Work in pairs. Discuss the application and challenges of mathematical modeling. Use the questions and useful phrases provided below to help structure your response.***

1. Imagine an everyday scenario when mathematical modeling proves to be useful.

2. How is mathematical modeling used in the sphere of your professional interests?

3. Have you heard of any emerging trends in mathematical modeling?

4. Can you give examples of real-world problems that have been solved using mathematical modeling?

5. What are the advantages of using mathematical modeling for problem-solving purposes?

6. In what ways does mathematical modeling help in understanding complex ideas or concepts?

7. What are some common problems that might arise when developing mathematical models?

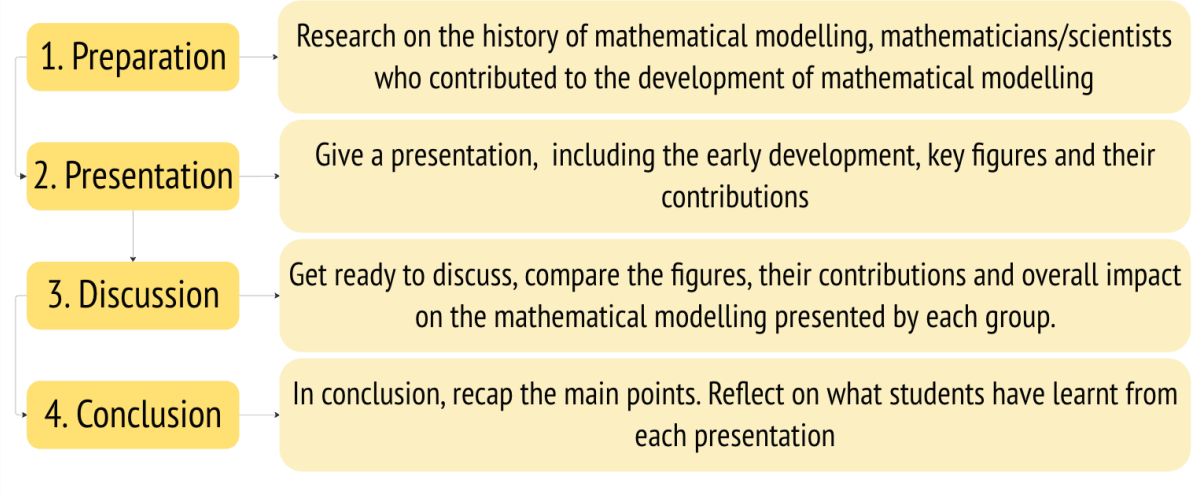
Useful phrases:

- ✓ *In my opinion / From my perspective … …*
- ✓ *It seems to me that / I think that … …*
- ✓ *As I see it / It appears that … …*
- ✓ *To my mind / As far as I'm concerned … …*
- ✓ *To be honest … …*
- ✓ *From where I stand … …*
- ✓ *In my view … …*

24. ***Work in groups. Prepare a presentation about the history of mathematical modeling: historical figures and their contributions to the field. Each group introduces a scientist or mathematician known for their work in mathematical modeling and provides a brief overview of their contributions. Improve your presentation by following the outline and useful phrases provided below.***

Useful phrases for presenting:

- ✓ *In this presentation, we will explore / overview … …*
- ✓ *The purpose / aim of this presentation is to … …*
- ✓ *The focus of our presentation is on … …*
- ✓ *Moving forward to … …*
- ✓ *The main contributions / developments / achievements … …*
- ✓ *Another scientist / mathematician is … …*
- ✓ *In conclusion / To sum up, our teamwork provided insight … …*



WRITING

25. ***You are participating in an academic program focused on mathematical modeling. Research the recent news article or research papers about applications of mathematical modeling and write a summary (80-120 words) of the article or research paper. Include main ideas, arguments, and perspectives. Pay attention to clarity, coherence, and accuracy in your writing. Use phrases for summarizing and keywords in the box below.***

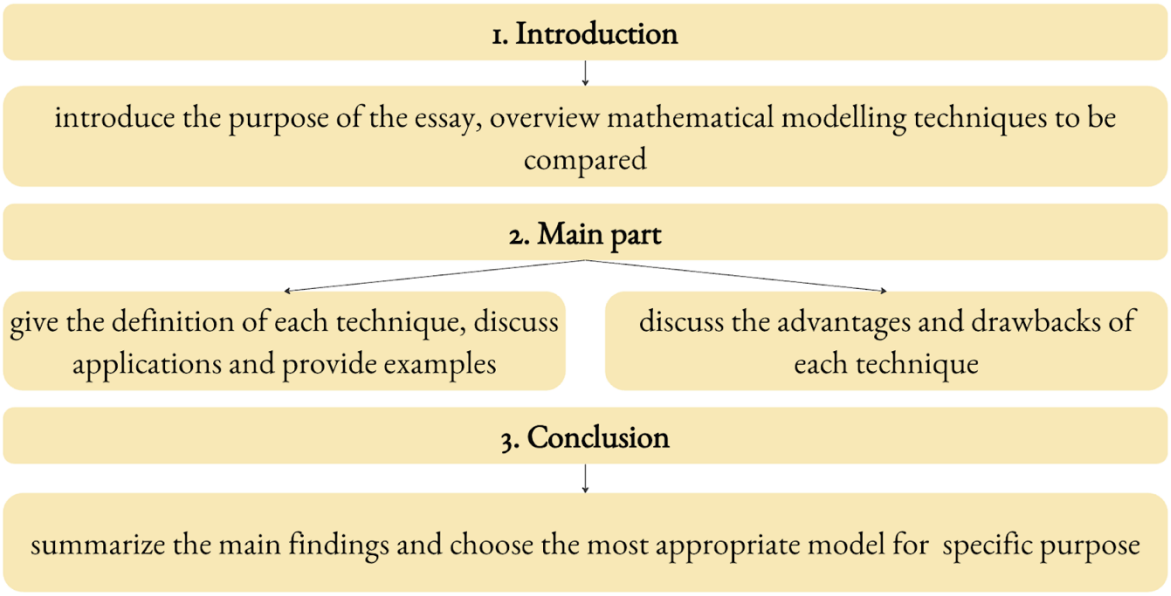
Useful phrases for summarizing:

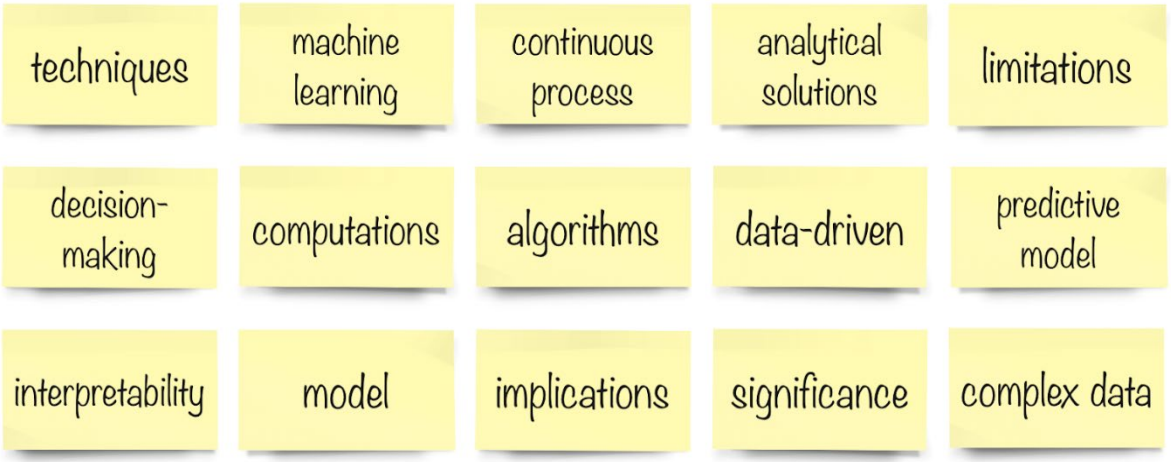
- ✓ *The article / paper is about / presents / describes … …*
- ✓ *Then / next … …*
- ✓ *According to … …*
- ✓ *Overall … …*
- ✓ *In brief … …*
- ✓ *To outline … …*
- ✓ *In summary / conclusion … …*

26. ***You are writing an essay.***

Useful phrases for writing an essay:

- ✓ *This essay addresses / looks into / explores / discusses … …*
- ✓ *As an example / To illustrate this … …*
- ✓ *It is worth noting / highlighting that … …*
- ✓ *Furthermore / Moreover / Additionally / In addition to … …*
- ✓ *Moving to the next point / Shifting our focus to … …*
- ✓ *In contrast to this … …*
- ✓ *In conclusion / To sum up / In closing … …*





REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic*** **"Mathematical Modeling"** ***using flashcards and then assess comprehension through a Quizlet quiz.***

28. *Self-assessment test.*

1. Which term describes the relationship where one variable is defined as a function of multiple other variables?

A. distinct values

B. algebraic relationship

C. calculations

D. common terms

2. What term does the 'independent variable' refer to?

A. variable that isn't influenced by any other variables

B. variable that can be influenced by any other variables

C. variable that responds to a change in another variable

D. outcome variable

3. Which term is defined as techniques to approximate mathematical processes?

A. mathematical modeling

B. dependent variable

C. numerical method

D. distinct values

4. What type of equation describes the equation that consists of one or more functions of one independent variable along with their derivative?

A. ordinary differential equation

B. linear differential equation

C. partial differential equation

D. nonlinear differential equation

5. $dy / dx + Py = Q$ is a standard form of …

A. ordinary differential equations

B. linear differential equations

C. partial differential equations

D. nonlinear differential equations

6. What term refers to the process of making something officially approved?

A. discrete

B. formulation

C. general sense

D. validation

7. Which term can be synonymous to ‘separate’?

A. discrete

B. sequential

C. reflective

D. complicated

8. Which term commonly refers to the measurement of height, weight, etc.?

A. equation

B. dimensions

C. composition

D. state

9. is the opposite of ‘complicate’?

A. evaluate

B. express

C. simplify

D. reflect

10. What expression can be defined as based on experience rather than theory?

A. distinct values

B. empirical data

C. external influences

D. model refinement

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas and concepts were easy to understand.*	***Yes / No / Partially***
Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I properly used terms and concepts to talk about mathematical modeling. I learned new words and word combinations and used them actively during the lessons..*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic easy and now I can discuss relevant ones.*	***Yes / No / Partially***
Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***

Learning experience	*I think understanding mathematical concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of mathematical modeling.*	***Yes / No / Partially***

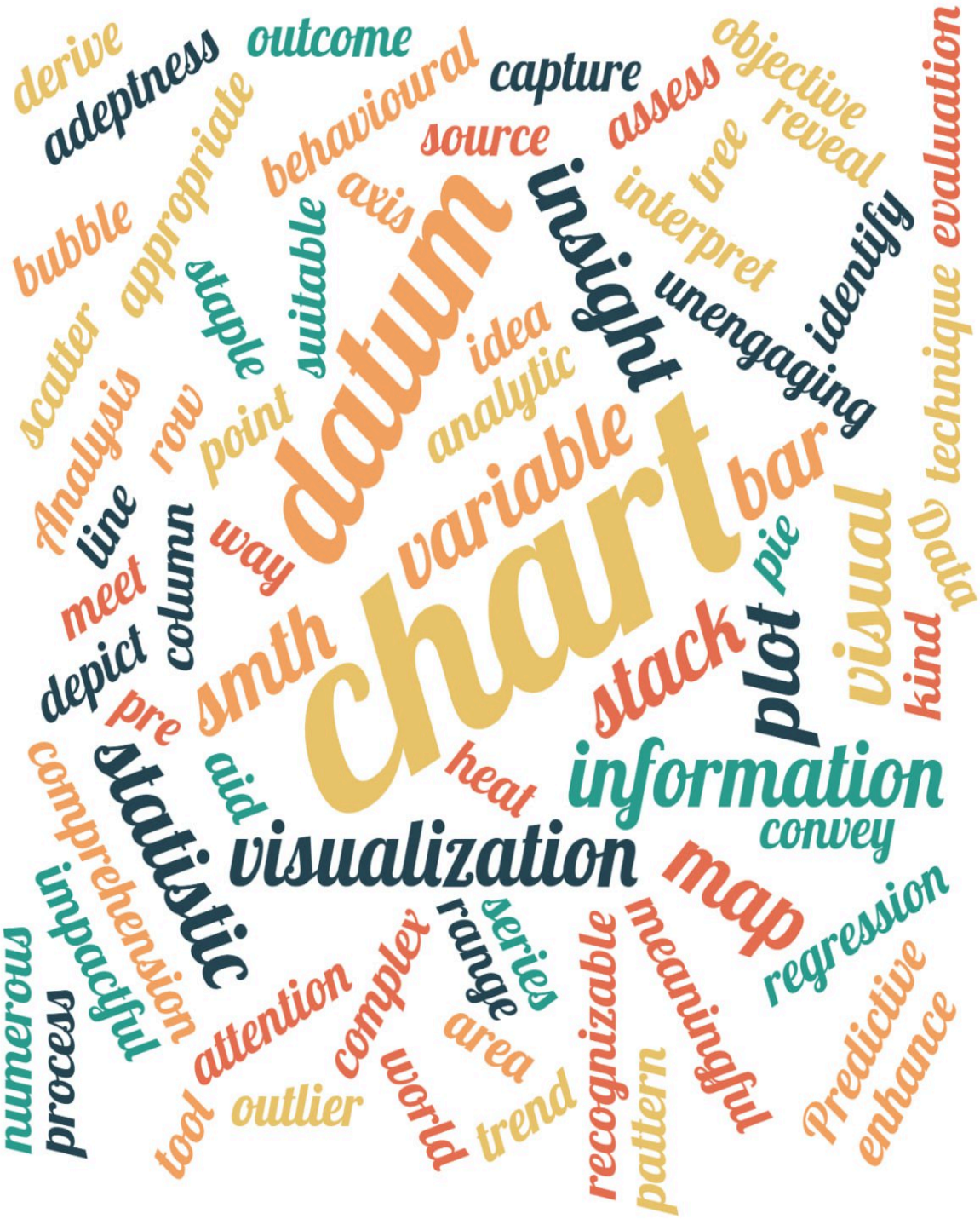
You didn't choose "Yes" for each statement? Don't worry! Turn

Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*
Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, write down new vocabulary, learn through media, learning from the context. Use can visit,* ***https://youglish.com/*** *an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*

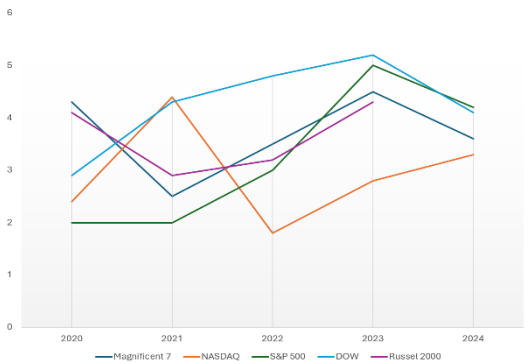
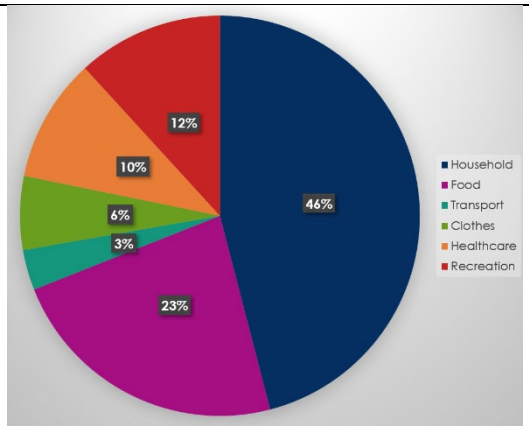
Listening	*Focus on improving your listening comprehension by watching English-language media.*
Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*
Speaking	*Don't be afraid to make mistakes while speaking. Feel free to express your opinion even if you think it doesn't correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*
Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience. Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

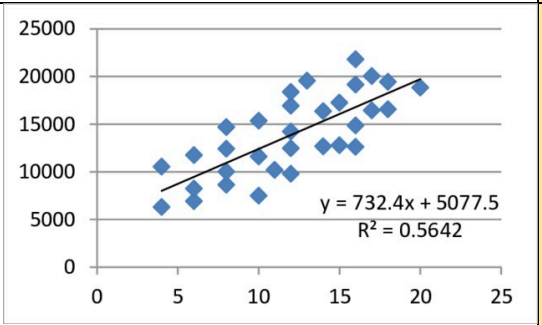
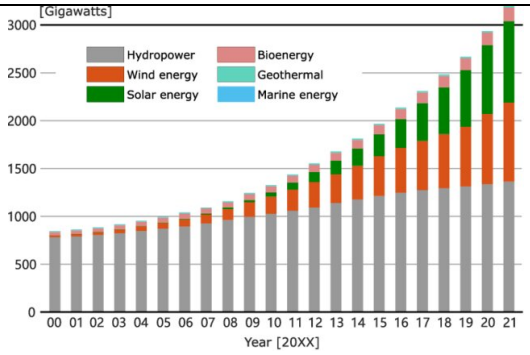
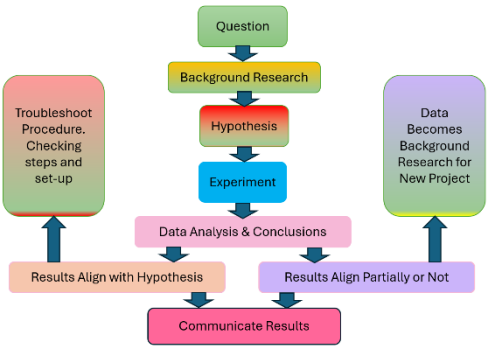
Unit 6

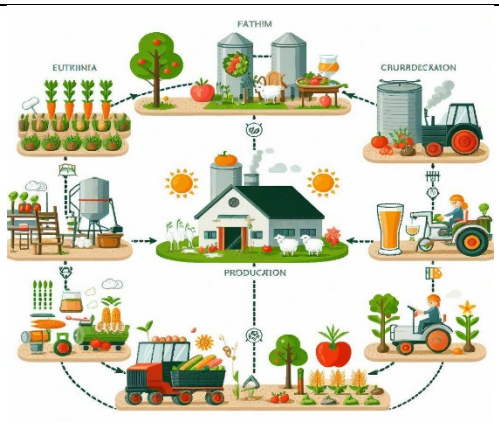
DATA VISUALIZATION



LEAD-IN

1.		**A**	Map. Demonstrates the principle of geographic representation by showing variations in the Internet accessibility and usage across different regions of the world.
2.		**B**	Infographic. Communicates complex environmental concepts in a clear and engaging manner, highlighting the potential benefits of sustainable energy practices.
3.		**C**	Line graph. Illustrates the principle of trend analysis by graphically displaying the movement of stock market values over a specific time period.
4.		**D**	Flowchart. Outlines the sequential steps involved in conducting a scientific investigation or experiment. It provides a visual guide for researchers to follow,

			ensuring a systematic approach to experimental design and data collection.
5.		**E**	Diagram. Demonstrates the principle of process visualisation by depicting the stages involved in the production and distribution of food from farms to consumers.
6.		**F**	Scatter plot. Utilises the principle of correlation analysis to visualise the relationship between two variables, depicting their with plotted points on a graph.
7.		**G**	Bar chart. This type of visualisation allows viewers to quickly understand how usage patterns vary across demographic segments.

8.		**H**	Pie chart. Represents the principle of proportional representation by visually depicting the distribution of expenses within a household budget.

…

…

…

…

’m not too familiar with this topic, but … …

’m absolutely convinced that … …

…

’m concerned, … …

“Data are just summaries of thousands of stories – tell a few of those stories to

“The purpose of visualisation is insight, not pictures.”

“

“If you torture the data long enough, it will confess.”

“

“The skill of the visualiser is that you don’t have to think twice to understand it.”

“There are three kinds of lies: lies, damned lies, and statistics.”

“

READING

4. ***Before you read the text about data visualisation and infographics, discuss these questions in pairs. Then read the text and check your answers.***

1. Why are infographics considered powerful tools for communication?

2. What stages are involved in the process of information visualisation, and why is each stage important?

3. How do different types of visual aids, such as tables, pie charts, and histograms, contribute to the effective communication of data?

4. What role does audience consideration play in selecting the appropriate chart or graph type for data communication?

5. Can you explain how infographics transform complex data into easily understandable visuals, and why is this transformation significant?

6. In what ways can scatter plots and heat maps serve as effective tools for visualising data, and what types of information are they particularly useful for representing?

Infographics are visual representations of data and other forms of information. They combine text, images, illustrations, and data visualizations like charts and graphs to communicate ideas in ways that are quick and easy to understand. “Infographic” is a portmanteau of the words “information” and “graphic.” In essence, an infographic is a form of visual communication meant to capture attention and enhance comprehension. In this era, “infographic” has become the broadest descriptor of a specific type of visual communication that

includes graphics showing data, copy, or both.

Infographics are a great way of taking important, but sometimes confusing or un-engaging statistics and information, and presenting them as fun and easily understood graphics! Infographics are important tools for academics, businesses, creatives, and anyone else hoping to share knowledge or data in a quick, concise, and clear way!

1. Data collection: Gathering relevant data from diverse sources to form the basis for visualization.

2. Data analysis: Examining and processing the collected data to identify patterns, trends, and insights.

3. Data pre-processing: Cleaning and organizing the data to make it suitable for visualization.

4. Visual representation: Choosing appropriate visualization techniques to represent data accurately and effectively.

5. Interaction design: Developing user-friendly interfaces that allow meaningful interaction with the visualized data.

6. Interpretation: Enabling users to interpret and derive insights from the visualized information.

7. Evaluation: Assessing the effectiveness of the visualization in conveying information and meeting objectives.

When selecting the right type of chart or graph, it is essential to consider the audience and the message you want to communicate. Therefore, selecting the

right type of chart or graph is crucial to effectively communicate data insights to the audience.

5. ***Read the text again. Decide whether the following statements are True (T) or False (F). Fill in the table with your answers.***

1. The term “infographic” originated from the combination of the words “information” and “graphic”, emphasising textual content over visual elements.

2. Infographics use visuals like text, images, and charts to effectively communicate data and information.

3. Infographics are helpful for making complex statistics and information engaging and easy to understand through entertaining graphics.

4. Infographics are only useful for academics and businesses, not for anyone else wishing to share knowledge swiftly and briefly.

5. The potency of infographics resides in the skillful conveyance of intricate concepts with speed and efficiency, enabling thorough comprehension in detail.

6. Graphic designs simplify complex concepts into recognisable outcomes, serving as effective communication tools.

7. Information visualisation encompasses seven stages that start with evaluating the efficacy of communicating information and achieving goals.

8. In information visualisation, it's crucial to cleanse and arrange the data to ensure its suitability for representation purposes.

9. A variety of visual tools, such as tables, pie charts, and infographics, cater to different types of information, ensuring optimal representation for each data type.

10. Line and area charts are not suitable for predictive analytics, as they sometimes inadequately represent changes over time, resulting in confusion.

11. Histograms present data distribution with bars, facilitating the identification of outliers by leaving spaces between the bars to represent the quantity of data within a range.

12. Choosing the right chart or graph type is essential for effectively communicating data insights, contingent upon considering the audience and message.

USE of ENGLISH

	Column A		Column B
1.	area	A	design
2.	behavioral	B	plot
3.	complicated	C	chart
4.	predictive	D	techniques
5.	scatter	E	interface
6.	visual	F	data
7.	visualization	G	ideas
8.	capture	H	concept
9.	engaging	I	analytics
10.	complex	J	statistics
11.	graphic	K	outcomes
12.	user-friendly	L	aid
13.	line	M	descriptor
14.	recognizable	N	attention
15.	broadest	O	segments

8. ***Explain the meanings of the phrases in column A. Then complete the sentences in column B with your ideas.***

		clearly shows …
		that…
		into customer preferences by …
		, confirming …
		visualization helps to represent …
		for …
		’s *inundated information world*, it’s crucial …
		of …
		on a scatter plot can …
		is used in many …
		can help determine…
		showed …
		and …
		about …
		of …

1. to _____ ideas in ways that are quick and easy to understand;
2. a form of visual communication meant to _____ attention;
3. become the broadest _____ of a specific type of visual communication;
4. a process that transforms complex data into _____ visuals;
5. gathering _____ data from diverse sources;
6. organizing the data to make it suitable for _____;
7. to represent data _____ and effectively;
8. _____ interfaces;
9. to interpret and derive _____ from the visualized information;
10. rows and _____ used to compare variables;
11. frequently used within _____ analytics;
12. beneficial in revealing the _____ between two variables;
13. display hierarchical data as a set of _____ shapes;
14. comparing the _____ between categories via their area size;
15. to effectively communicate data insights to the _____.

1

1.

	Column A		Column B
1.	visual	A	proficiency
2.	representation	B	understanding
3.	combine	C	demonstrate
4.	comprehension	D	graphic
5.	capture	E	depiction
6.	present	F	proficiently
7.	concise	G	unite
8.	effectively	H	collection
9.	adeptness	I	grasp
10.	recognisable	J	inspecting
11.	gathering	K	succinct
12.	examining	L	fitting
13.	appropriate	M	identifiable
14.	suitable	N	proper
15.	accurately	O	precisely

scatter plot	illustration	bar chart	insights	pre-processing
pie chart	line graph	interpretation	infographics	visual aid
table	data set	flow chart	adeptness	comprehension

1

2

3

4

5

6

7

8

9

1

1

1

2

1

3 1

4 1

5

.


social
images
flexibility
product
network
presentations
media
attention
visualization
information
interact
interactivity
infographics
visual
element

that has taken the world by storm. Whether they're GIFs or videos, animated

Adopted from: https://pressbooks.nscc.ca/comm1205/chapter/12-6-the-infographic/
https://medium.com/@PrezLab/infographic-basics-what-how-and-why-to-use-them-b75777fe92b7

1.	a) *graphic*	b) *scheme*	c) *plan*
2.	a) *effective*	b) *important*	c) *essential*
3.	a) *numbers*	b) *data*	c) *information*
4.	a) *create*	b) *make*	c) *present*
5.	a) *title*	b) *plan*	c) *composition*
6.	a) *elements*	b) *parts*	c) *ideas*
7.	a) *balance*	b) *elements*	c) *parts*
8.	a) *paragraph*	b) *composition*	c) *text*
9.	a) *elements*	b) *parts*	c) *components*
10.	a) *components*	b) *manner*	c) *style*
11.	a) *form*	b) *design*	c) *shape*
12.	a) *photos*	b) *pictures*	c) *colors*
13.	a) *thoughts*	b) *memory*	c) *brains*
14.	a) *personal*	b) *individual*	c) *professional*
15.	a) *pictures*	b) *texts*	c) *numbers*

Grammar Box

Articles

1

5

:"a / an", "the", *and* "0".

1) An article _____ is used to talk about 1 unspecified countable object.	*People use infographics to quickly communicate a message.*

2) An article _____ is used to talk about any number of specified objects (countable or uncountable).	*The process of creating infographics is sometimes referred to as data visualization.*
3) An article _____ is used to talk about a unique object.	*The World Bank provides a wealth of data on global development, along with other datasets that are useful for researchers, policymakers, and the general public.*
4) An article _____ is used when we mention the object for the first time we need to use article, but when we already know the object.	*Today, you can set up a personal data science lab right on your desktop. The lab with powerful programming tools allows you to conduct a range of data science activities.*
5) An article _____ is used when we mention somebody's job title.	*You don't need to be a professional designer to create an infographic.*
6) An article _____ is used when we talk about things in general.	*You collect data because you want to know something about it.*
7) An article _____ is used when before the noun we have numbers, pronouns, or with most proper nouns.	*The past 10 years have also brought about significant changes in the graphic capabilities of average machines.*

"a / an", "the", ***and*** **"0"** ***with the examples of their use in the sentences.***

1.	*any object, not specified*	**A.**	A dedicated data visualization software can provide powerful tools and features such as interactive dashboards, real-time data updates, a variety of chart types, and the ability to integrate with multiple data sources.
2.	*the object is specified*	**B.**	Their technology helps customers see patterns, trends, and outliers in their data by providing an easy-to-use interface for displaying data as charts, graphs, and other visualizations.
3.	*unique object*	**C.**	As a data scientist, you must be able to use programming languages like Python or R, along with data visualization libraries, to create complex charts and graphs.

4.	*object is mentioned for the first time*	**D.**	With this tool, you can create a simple pie chart and a scatter plot, which can be versatile for visualizing a broad range of data types.
5.	*a job title*	**F.**	The X-axis is usually used to represent time, such as years, months, or days.
6.	*things in general*	**G.**	In our enterprise, the leaders in data-informed designs blend cutting-edge technology with a deep understanding of user needs to develop highly functional and efficient designs.
7.	*a noun with a number*	**H.**	The chart shows a clear comparison of sales figures across different regions, highlighting trends and patterns in a visually engaging way.
8.	*a proper noun*	**I.**	When you first glance at this data visualization, what can you gather in just a second? How about in 5 seconds? In 15 seconds? In 40 seconds?
9.	*indefinite article is used instead of the number one*	**J.**	You can use five tools like Tableau, Power BI, D3.js, Google Charts, and Plotly to analyze data, present it in engaging charts and graphs, and share your insights with others.
10.	*the certain group of people*	**K.**	Quantitative visualization makes accurate measurements and comparisons possible. Quantitative visuals such as scatter plots and bar charts are examples.

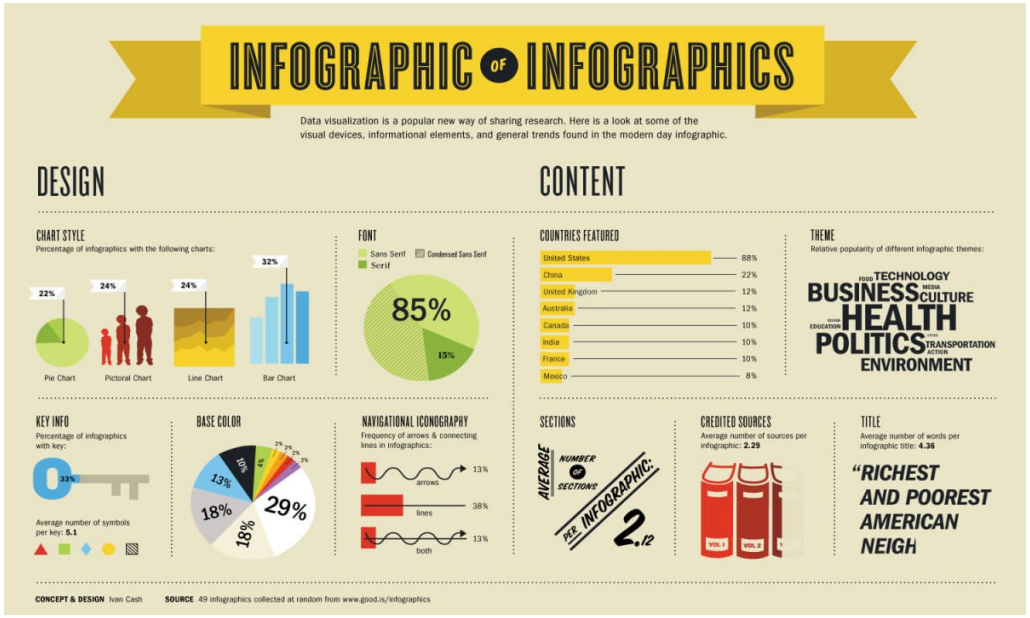
a	**an**	**the**	**no article**

all-too-frequent situation: approaching visualization problems with the question, “How can we possibly understand so much data?”

visualization project, it's common to focus on all the data that has been collected so far. The amounts of information might be enormous – ***10)*** _____ likes to brag about how many gigabytes of data they've collected and how difficult ***11)*** _____

broad scope, as in "exploratory data analysis" tasks, the answers themselves will

LISTENING


INFOGRAPHIC OF INFOGRAPHICS
Data visualization is a popular new way of sharing research. Here is a look at some of the visual devices, informational elements, and general trends found in the modern day infographic.
DESIGN
CONTENT
CHART STYLE
Percentage of infographics with the following charts:
22%
24%
24%
32%
Pie Chart
Pictoral Chart
Line Chart
Bar Chart
FONT
Sans Serif
Condensed Sans Serif
Serif
85%
15%
COUNTRIES FEATURED
United States 88%
China 22%
United Kingdom 12%
Australia 12%
Canada 10%
India 10%
France 10%
Mexico 8%
THEME
Relative popularity of different infographic themes:
TECHNOLOGY
BUSINESS
CULTURE
HEALTH
POLITICS
TRANSPORTATION
ENVIRONMENT
KEY INFO
Percentage of infographics with key:
33%
Average number of symbols per key: 5.1
BASE COLOR
29%
18%
18%
13%
NAVIGATIONAL ICONOGRAPHY
Frequency of arrows & connecting lines in infographics:
arrows 13%
lines 38%
both 13%
SECTIONS
AVERAGE NUMBER OF SECTIONS PER INFOGRAPHIC:
2.12
CREDITED SOURCES
Average number of sources per infographic: 2.29
TITLE
Average number of words per infographic title: 4.36
"RICHEST AND POOREST AMERICAN NEIGH
CONCEPT & DESIGN Ivan Cash
SOURCE 49 infographics collected at random from www.good.is/infographics

1


beverage
distribution
cluster
controversial
plaque
plotted
ravaged
superfluous
to embellish information
omitted
literal representation
visual cues

"The Evolution of Infographics: A Detailed History". Decide whether the

2. Around 25,000 BC, the oldest known map was made; it was found in the Czech Republic.

3. The ancient Egyptians were known to use intricate hieroglyphic symbols not only for communication but also for creating early forms of data visualizations.

4. The Babylonian map of the world created around 600 BC was a literal representation of Babylonia.

5. More than a thousand stars were painted in the Dunhuang Star Atlas, which dates to between 649 and 684 AD.

7. During the Renaissance period, a secretive group of artists in Italy developed a series of coded visual charts to communicate political messages to the ruling elite.

8. The city council intervened and closed the area when physician John Snow's 1854 map of cholera cases in London revealed a sizable cluster centered on a water pump on Broad Street.

9. In 1933, Harry Beck revolutionized the design of city tramway maps in Manchester, showcasing a new approach to visualizing public transportation routes.

10. Since the 1990s, the terms "information graphics" and "infographic" have been used interchangeably.

11. Infographics can't be as basic as a road sign warning of impending work; they can only be used for intricate visual assessments.

12. Infographics are used by marketers, employees, and educators for a variety of tasks, including lead generation, business reports, and instruction.

1. The beginnings of infographics aren't just _____ to caves and rocks, though.

2. On the other hand, the earliest hieroglyphic writing from _____ dates back to around 3,000 BC.

3. By the 18th century, scientists and scholars were already warming to the idea of arranging knowledge _____.

4. In 1764, British polymath Joseph Priestley produced a chart of biographies, illustrating the lives of roughly _____ historical figures on a timeline.

5. The 1830s saw the birth of _____ social science.

6. Three years later in 1857, English nurse Florence Nightingale used the Coxcomb chart to _____ Queen Victoria to improve military hospital conditions.

7. The map _____ President Abraham Lincoln's attention to where slavery was weakest.

8. This was a _____ in infographics since it showed that visual diagrams could be used for everyday life.

9. Aluminum _____ plaques with pictorial messages were placed aboard the Pioneer 10 and 11 spacecraft.

11. By 1975, Edward Tufte, considered the father of data visualization, developed a seminar on _____ graphics alongside John Tukey.

12. Tufte argues that any _____ visual elements that do not communicate specific information are superfluous and should be omitted.

SPEAKING

- ✓ *To begin with … …*
- ✓ *Visualization tool like … is used for … …*
- ✓ *Similarly / In other words … ….*
- ✓ *For what it's worth / Basically … …*
- ✓ *Let me give you some examples … …*
- ✓ *Additionally / Furthermore / Moreover … …*
- ✓ *In conclusion / To sum up … …*

- ✓ *Let's look at a wide range of jobs / skills associated with … …*
- ✓ *Among the essential skills required for … …*
- ✓ *One of the key skills necessary for … …*
- ✓ *Communication / critical thinking is important for … …*
- ✓ *One of the foundational skills in … is … …*
- ✓ *Other important skills include … …*
- ✓ *In conclusion … …*

- ✓ *Our dataset reveals / shows … …*
- ✓ *This visualization illustrates … …*
- ✓ *One trend we can observe … …*
- ✓ *Our findings illustrate the … …*
- ✓ *Moving forward … …*
- ✓ *Our visualization highlights the importance of … …*
- ✓ *In conclusion / To summarize / Overall … …*

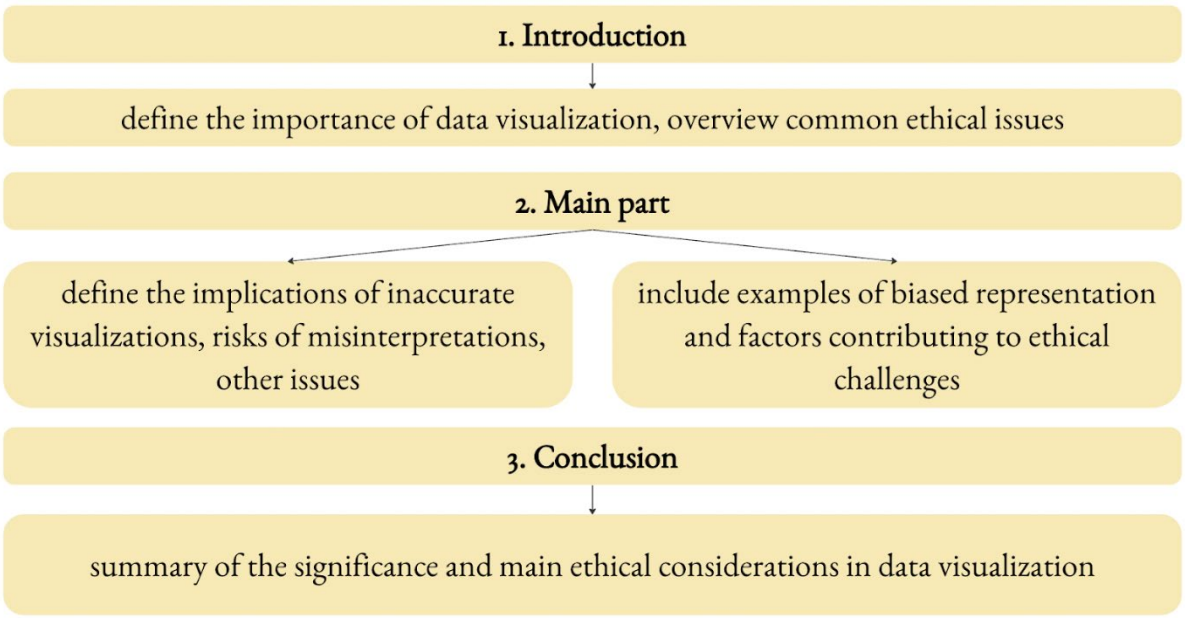
- ✓ *Our group would like to present a visualization that … …*
- ✓ *The visualization we've selected illustrates / effectively conveys …*
- ✓ *The data present i visualization is … …*
- ✓ *The use / choice of colour / visual elements … …*
- ✓ *It could benefit from improvements in … …*
- ✓ *To improve … we could consider … …*
- ✓ *Overall, this visualization … …*

WRITING

- ✓ *I'd like to introduce … …*
- ✓ *First (ly) / second (ly) / third (ly) … …*
- ✓ *Another / additionally / next … …*
- ✓ *By contrast / compared with … …*
- ✓ *Additionally / also / besides … …*
- ✓ *For example / for instance / especially … …*
- ✓ *In conclusion, I recommend … …*

- ✓ *This essay / looks into / explores / discusses … …*
- ✓ *In the recent years / lately … …*
- ✓ *Ethical considerations arise when … …*
- ✓ *It poses ethical challenge(s) … …*
- ✓ *Misinterpretation(s) of data visualization may lead to … …*
- ✓ *As an example / To illustrate this … …*
- ✓ *In conclusion / To sum up / In closing … …*

ethical implications	accuracy	integrity	reliability	truthfulness
misrepresentation	representation bias	fairness	inclusivity	stereotypes
context	interpretation	credibility	limitations	transparency



REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic "Data visualisation" using flashcards and then assess comprehension through a***

28. ***Self-assessment test.***

1. What term describes the skills or proficiency in something?

A. trend

B. adeptness

C. evaluation

D. suitable

2. What type of chart is usually used to represent changes over time?

A. area chart

B. bar chart

C. pie chart

D. bubble chart

3. What type of chart shows values as circles of different sizes?

A. bubble chart

B. area chart

C. bar chart

D. pie chart

4. What type of chart is shown as a circle divided into parts to illustrate how the total amount is divided?

A. tree map

B. area chart

C. bar chart

D. scatter plot

5. What term refers to a fixed line on a chart that represents the position of a point?

A. chart

B. axis

C. column

D. scatter plot

6. Why is it important to identify outliers?

A. to convey complex ideas

B. to capture attention

C. to compare variables

D. for accurate results

7. Which term can be synonymous to ‘staple’?

A. suitable

B. portmanteau

C. main product

D. trend

8. A picture or a video is an example of …

A. scatter plot

B. unengaging statistics

C. hierarchical data

D. visual aid

9. What is the opposite of ‘not good enough’?

A. suitable

B. unengaging

C. confusing

D. meaningful

10. What type of data visualisation can be used to show the value of recent home sales in the area?

A. tree map

B. heat map

C. scatter plot

D. bubble chart

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas and concepts were easy to understand.*	***Yes / No / Partially***
Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I properly used terms and concepts to talk about data visualisation. I learned new words and word combinations and used them actively during the lessons.*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic easy and now I can discuss relevant ones.*	***Yes / No / Partially***

Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***
Learning experience	*I think understanding mathematical concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of data visualisation.*	***Yes / No / Partially***

You didn't choose "Yes" for each statement? Don't worry! Turn

Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*

Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, write down new vocabulary, learn through media, learning from the context. Use can visit,* ***https://youglish.com/*** *an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*
Listening	*Focus on improving your listening comprehension by watching English-language media.*
Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*
Speaking	*Don't be afraid to make mistakes while speaking. Feel free to express your opinion even if you think it doesn't correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*

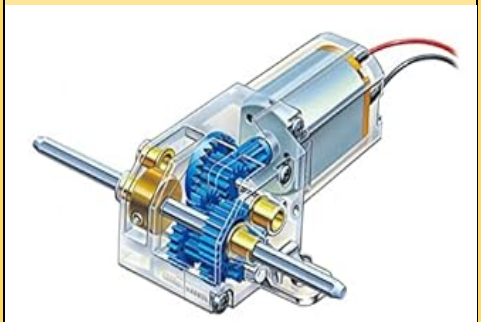
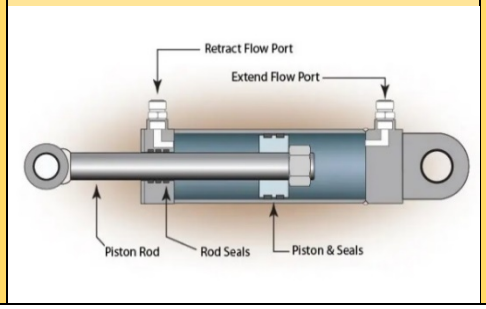
Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience. Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

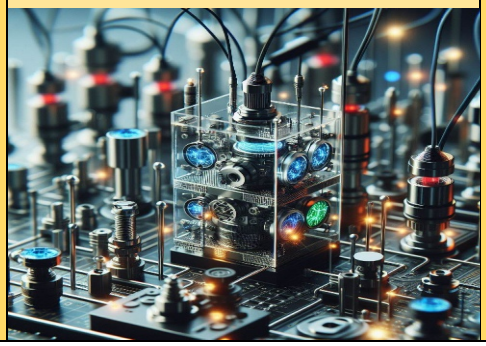
Unit 7

BASICS OF ROBOTICS

LEAD-IN

1

1.		**A**	Robotic arm. A mechanical arm-like structure equipped with joints and end-effectors, designed to perform various tasks such as lifting, moving, or manipulating objects.
2.		**B**	Sensor array. A collection of sensors designed to detect and measure physical parameters or environmental conditions, providing feedback to the robotic system.
		**C**	Gear system. A mechanism consisting of interconnected gears that transmit power and motion between different parts of a machine.

4.		**D**	Conveyor belt system. A continuous moving belt is used to transport objects or materials from one location to another within a production or manufacturing environment.
5.		**E**	Gripper or end-effector. The part of a robotic arm responsible for grasping, holding, or manipulating objects during robotic operations.
6.		**F**	C panel or interface. An interface equipped with controls and displays that allow users to interact with and control the operation of robotic systems.
7.		**G**	Motor and gearbox. An electromechanical device that converts electrical energy into mechanical energy, often paired with a gearbox to control speed and torque.

8.		**H**	Linear actuator. A device capable of creating linear motion, often used to control the position or movement of robotic components.

2. ***Read the case studies. How does each matched component contribute to addressing specific challenges or requirements in the given case studies? What are the implications of using these components for achieving precision, speed, or versatility in robotic applications?***

✓ *Automotive manufacturing*: Assembly line robots require precise movement (precision) to install components with accuracy.

✓ *Warehousing and logistics*: Robotic arms equipped with grippers (versatility) are used to pick and pack items quickly and efficiently.

✓ *Pharmaceutical industry*: Conveyor belt systems are employed to transport delicate vials and containers (precision) without damage.

✓ *Aerospace industry*: Robotic arms with sensor arrays are used for non-destructive testing (precision) and inspection of aircraft components.

✓ *Agriculture*: Robotic systems equipped with sensors (precision) are used to monitor crop health and apply fertilisers or pesticides with accuracy.

✓ *Healthcare*: Robotic surgical systems require precise movement (precision) and speed to perform minimally invasive procedures.

✓ *Electronics manufacturing*: Robotic arms with precision linear actuators are used for soldering and assembly of small components with accuracy.

✓ *Food processing:* Conveyor belt systems are employed to transport food items through various stages of processing and packaging quickly.

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READING

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’s position concerning the environment.

USE of ENGLISH

	Column A		Column B
1.	elastic	A	axis
2.	fixed	B	element
3.	kinematic	C	joint
4.	meshing	D	bodies
5.	moving	E	creations
6.	physical	F	pair
7.	pivoting	G	elements
8.	prismatic	H	motion
9.	revolutionary	I	teeth

10.	rigid	**J**	layout
11.	machine	**K**	contact
12.	space	**L**	variety
13.	spatial	**M**	body
14.	primitive	**N**	connections
15.	rich	**O**	exploration

8. ***Explain the meanings of the phrases in column A. Then complete the sentences in column B with your ideas.***

		on the bridge …
		to …
		under …
		…
		that allowed …
		…
		allowing …
		to …
		, with …
		…
		, allowing …
		that …

		…
		that …
		when …

1. _____ with advanced sensors;

2. a machine capable of physical motion for interacting with the _____;

3. a set of machine elements or components or parts _____ in a specific order;

4. rigid or _____ bodies that do not deform under the action of forces;

5. suffer appreciable _____ or change in physical form;

6. transmitting the required forces with _____ deformation;

7. a multi-body system with _____ bodies connected together;

8. the relationship between a robot's joint coordinates and its _____ layout;

9. a single part which can be a resistant body having _____ connections;

10. go under deformation while _____ the force;

11. characterized by the type of _____ that it allows between the two elements;

12. to transmit motion or force between different parts of a _____ system;

13. transmit motion or force through sliding or rolling _____ between the two elements;

14. transmit motion or force through _____ teeth;

15. a revolute joint where a pair of links rotates about a fixed _____.

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	Column A		Column B
1.	emerge	**A**	*determined*
2.	transform	**B**	*competent*
3.	exploration	**C**	*operation*
4.	capable	**D**	*appear*
5.	manipulation	**E**	*organise*
6.	state	**F**	*numerous*
7.	specified	**G**	*connection*
8.	arrange	**H**	*change*
9.	joint	**I**	*rotate*
10.	resistant	**J**	*examination*
11.	consider	**K**	*condition*
12.	deform	**L**	*immune*
13.	multiple	**M**	*ponder*
14.	torque	**N**	*distort*
15.	inflexible	**O**	*unbending*

locomotion | torque | joint | kinematic pair | deform
resistant | elastic | gear | distortion | bearing
kinematics | artificial | cam | simulation | mechanism

1. Created by human beings, for example using science or technology.

2. The ability to move and the act of moving from one place to another.

3. A part of a machine or piece of equipment, often consisting of a set of smaller parts, which performs a particular function.

4. To change the shape.

5. To be opposed to something and want to prevent it.

6. The changing of the appearance or sound of something in a way that makes it seem strange or unclear.

7. Rubber material that stretches when you pull it and returns to its original size and shape when you let it go.

8. The study of the motion of bodies without reference to mass or force.

9. A force that causes something to spin around a central point such as an axle.

10. The imitative representation of the functioning of one system or process by means of the functioning of another.

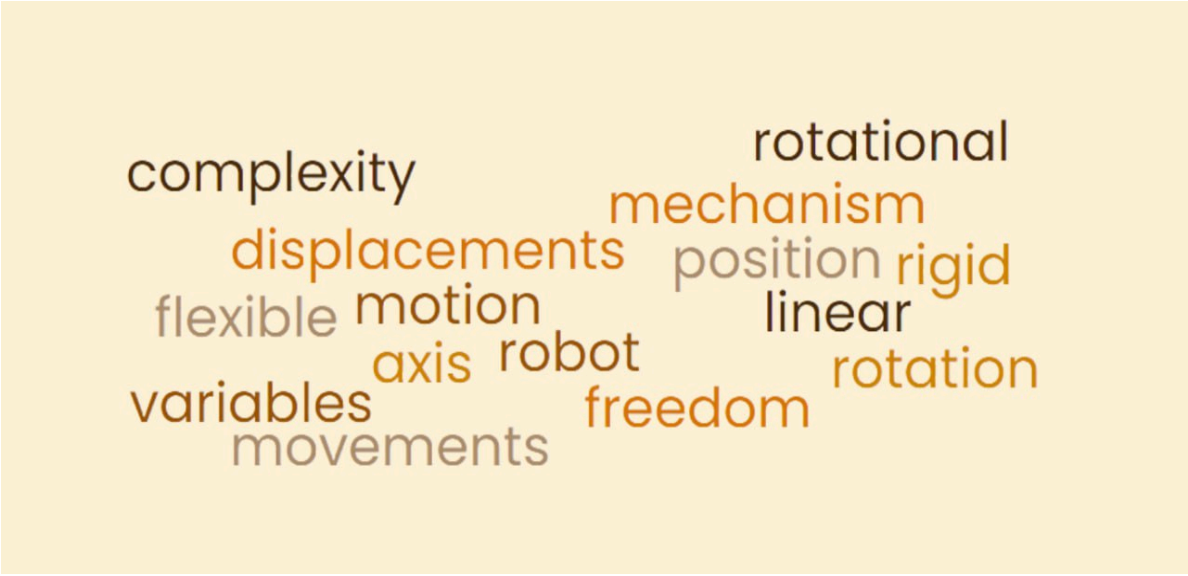
11. A part or space included between two articulations, knots, or nodes.

12. A connection between two physical objects that imposes constraints on their relative movement (kinematics).

13. A mechanism that performs a specific function in a complete machine.

14. A rotating or sliding piece (such as an eccentric wheel or a cylinder with an irregular shape) in a mechanical linkage is used especially in transforming rotary motion into linear motion or vice versa.

15. A machine part in which another part (such as a journal or pin) turns or slides.



In mechanics, degrees of freedom (DOF) is the number of independent ***1)*** _____ that define the possible positions or motions of a mechanical system in space.

The term “degrees of freedom” is widely used to define the ***2)*** _____ capabilities of robots, including androids (humanoid robots). In this context, the term generally refers to the number of joints or axes of motion on the ***3)*** _____.

DOF measurements assume that the ***4)*** _____ is both rigid and unconstrained, whether it operates in two-dimensional or three-dimensional space. The number of degrees of ***5)*** _____ is equal to the total number of independent ***6)*** _____ or aspects of motion.

Degrees of freedom apply to two types of motion: translational and rotational. The translational motion refers to the movement that is both ***11)*** _____ and non-rotational. ***12)*** _____ motion is just the opposite. An unconstrained, rigid mechanism in two-dimensional space (planar space) can potentially have three independent degrees of freedom: two translational and one rotational.

is the number of axes it has. It is often one of the first items listed when viewing a

Adopted from: https://www.techtarget.com/whatis/definition/degrees-of-freedom

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Gear Efficiency. By using gears, we lower our input-to-output power efficiency. This is due to obvious things such as ***11)*** _____, misalignment of pressure angles, ***12)*** _____, gear backlash (spacing between meshed gear teeth between two gears), and angular momentum, etc. Different gear setups, different types of gears, different gear materials, and wear and tear on the gear, will all have different ***13)*** _____.

The cam and follower are the machine elements that help to convert rotational or translational ***14)*** _____ into reciprocating or oscillating motion. The cam is the driver element while the follower is the driven element.

1.	**a)** *robots*	**b)** *motors*	**c)** *machines*
2.	**a)** *acceleration*	**b)** *motion*	**c)** *rotation*
3.	**a)** *motion*	**b)** *torque*	**c)** *speed*
4.	**a)** *energy*	**b)** *power*	**c)** *force*
5.	**a)** *gears*	**b)** *bearings*	**c)** *cams*
6.	**a)** *force*	**b)** *motion*	**c)** *speed*
7.	**a)** *reducers*	**b)** *actuators*	**c)** *motors*
8.	**a)** *speed*	**b)** *direction*	**c)** *distance*
9.	**a)** *precision*	**b)** *pressure*	**c)** *speed*
10.	**a)** *strain*	**b)** *strength*	**c)** *stress*
11.	**a)** *friction*	**b)** *acceleration*	**c)** *pressure*
12.	**a)** *rotation*	**b)** *movement*	**c)** *lubrication*
13.	**a)** *input*	**b)** *efficiencies*	**c)** *output*
14.	**a)** *motion*	**b)** *rotation*	**c)** *friction*
15.	**a)** *machine*	**b)** *mechanism*	**c)** *motor*

Grammar Box

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1) **Result / Time** clauses often contain verbs in the past, present, or future tense, depending on the timing of the action or event.	*The robot's performance significantly improved after the technicians upgraded its mechanical parts.*
2) A comma separates the time clause from the main (independent) clause when the time clause comes ***first / second***.	*Before the engineers implemented the new design, the robot's mechanical parts were prone to frequent malfunctions.*
3) The words *"therefore", "consequently"* introduce a clause of ***Purpose / Result***.	*The robot's systems experienced a critical error during the mission;*

	therefore, the entire operation was compromised.
4) ***Contrast / Result*** clause typically begins with subordinating conjunctions such as *"so ...that"*, or *"so…as to"*.	*The robot's mechanical systems were so outdated that they couldn't withstand the increased workload, leading to frequent breakdowns during operation.*
5) Phrases such as *"with the result that*", *"with the consequence that,"* or *"resulting in"* indicate the ***outcome / reason*** of a particular action.	*The robot's mechanical systems underwent extensive upgrades, resulting in improved efficiency and performance across various tasks.*
6) ***Purpose / Reason*** clauses contain conjunctions *"in order to", "in case"* and *"so as to"*.	*The engineers adjusted the robot's mechanical systems in order to optimize its efficiency and minimize energy consumption during operation.*
7) In the reason clause we use the word *"reason for"* with ***-ing form / to-infinitive*** to refer to the reason for something.	*The engineers explored the reason for optimizing the kinetic pairs of the robots, aiming to maximize their functionality and minimize energy consumption.*
8) Conjunctions like *'when,' 'while,' 'before,' 'after,' 'as soon as,' 'since,' 'until,'* are used to signify the temporal relationship between the action in the ***time / reason*** clause and the main clause.	*As soon as the sensors detect the presence of an object within its reach, the robot swiftly calculates the optimal trajectory for its gripping mechanism to initiate the grasping motion.*
9) A comma is always used ***after / before*** *"however", "nevertheless"* in clauses of contract.	*Despite the initial setbacks, the engineers persevered in refining the robot's mechanical systems; nevertheless, they achieved remarkable advancements in performance and durability.*
10) We can usually leave out the relative pronoun "*who*", "*which*", or "*that*" if it is followed by a ***verb / subject.***	*The engineers, whom we met during the conference, provided valuable insights into the design and function of the robot's joints and gears.*

I. The mechanical structure of a robot is a complex system of components that work together seamlessly to enable its functionality. At the core of the robot are its kinetic pairs, ***1)*** _____ (WHICH / WHO) consist of joints and gears. ***2)*** _____ (DUE TO / IN CASE) the presence of these components, the robot can execute movements with precision and flexibility. ***3)*** _____ (HOWEVER / CONSEQUENTLY), the robot's gripping mechanism, equipped with sensors,

assumes a vital role in engaging with its surroundings. The robot's gripping mechanism, ***4)*** _____ (WHICH / WHOSE) is equipped with sensors, and

plays a crucial role in interacting with its environment **5)** _____ (IN ORDER TO / BECAUSE) these components allow the robot to move with precision and flexibility. **6)** _____ (UNTIL / WHEN) the sensors detect an object, the robot's control system processes the information and commands the gripping mechanism to act. **7)** _____ (SINCE / AS A RESULT), the robot can manipulate objects with ease and accuracy. Furthermore, the robot's power source, typically a battery or electrical outlet, provides the energy needed to drive its mechanical components. **8)** _____ (DESPITE / THE REASON WHY) the intricacy of its structure, the robot operates efficiently and autonomously. Overall, the mechanical structure of a robot is a testament to the ingenuity of engineering and the advancements in technology.

LISTENING

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8.

payload	curcuit boards	squeezed	auxiliary axes
servo motor	fuse	misfire	lubricated
unergonomic conditions	peripheral equipment	servo encoder	electrical cabinet

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9. A

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“What is a 6-A

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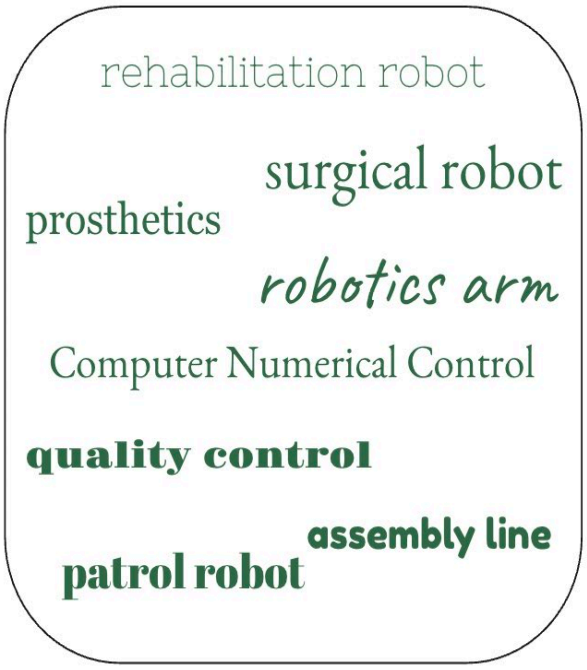
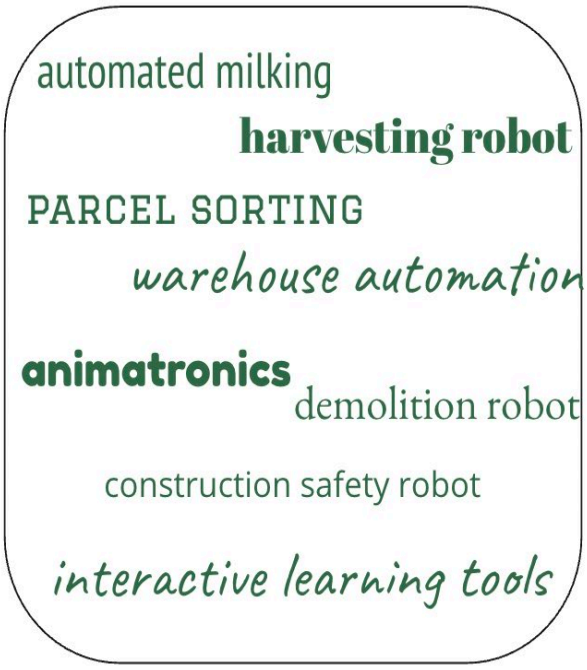
8. Joint 6 only needs to move the _____ in a specific motion, a motion much like moving your wrist.

SPEAKING

21. ***Think about spheres where robots are commonly utilized. Look at the words in the boxes below that are related to different spheres of robotics, and name them. Use the phases below to explain how the word / term is related to the specific sphere of robotics.***





- ✓ *I think so, because in [sphere], robots are commonly used on / for … …*
- ✓ *The term / word is likely related to [sphere] because … …*
- ✓ *This sounds like it's related to [sphere], because … …*
- ✓ *It seems to fit [sphere] because … …*
- ✓ *I'd say it belongs to [sphere] because … …*
- ✓ *The term / word suggests a direct link to [sphere] … …*
- ✓ *From my understanding, [sphere] often utilizes … …*

Useful phrases:

- ✓ *To begin with … …*
- ✓ *Firstly … …*
- ✓ *In addition … …*
- ✓ *Furthermore … …*
- ✓ *For example … …*
- ✓ *To conclude … …*
- ✓ *Last but not least … …*

- ✓ *Let's start by discussing the challenges associated with … …*
- ✓ *Let's explore the specific issues in … …*
- ✓ *One of the key challenges is … …*
- ✓ *One of the innovative solutions is … …*
- ✓ *I agree that [problem] is a great challenge … …*
- ✓ *I understand your perspective … …*
- ✓ *To summarize, the several challenges are … …*

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- ✓ *To start with, I'd like to point out … …*
- ✓ *Speaking of … …*
- ✓ *My first / second / … / next argument is … …*
- ✓ *An argument for / in favour of / against if … …*
- ✓ *There are many examples for … …*
- ✓ *I'm afraid I can't quite agree with … …*
- ✓ *To sum up, here are the main points … …*

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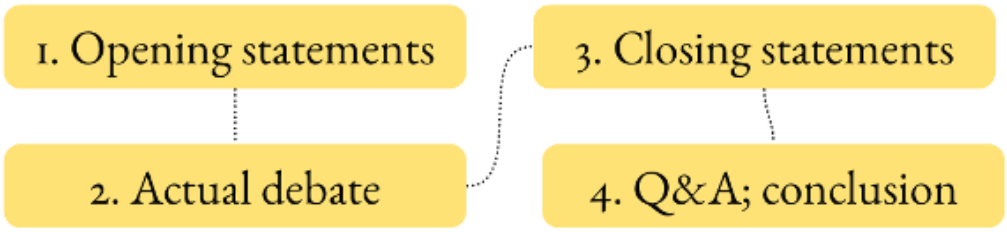

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WRITING

- ✓ *The aim / purpose of this essay is to outline / present / discuss … …*
- ✓ *The term … is used to describe … …*
- ✓ *This (technology) finds application in / can be incorporated … …*
- ✓ *Now let's focus on … …*
- ✓ *It is apparent / obvious / clear / evident that … …*
- ✓ *Looking ahead … …*
- ✓ *In conclusion / summary … …*

evolution	advancements	applications	industrial automation	autonomous vehicles
exploration	defense	artificial intelligence	human-robot interaction	ethical considerations
regulatory frameworks	collaboration	society	technology	innovation

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- ✓ *The aim / purpose is … …*
- ✓ *Then / next … …*
- ✓ *According to … …*
- ✓ *Overall … …*
- ✓ *In brief … …*
- ✓ *To outline … …*
- ✓ *In summary / conclusion … …*

REFLECTION and SELF-ASSESSMENT

27. ***Explore the target vocabulary related to the topic*** **"Automation in Robotics"** ***using flashcards and then assess comprehension through a Quizlet quiz.***

28. ***Self-assessment test.***

1. What term refers to the movement of an object?

A. action of forces

B. deformation

C. inflexible connections

D. translational displacement

2. What term refers to the ability of the body to stretch and return to its original shape?

A. elastic body

B. multi-body system

C. articulated joint

D. fixed axis

3. What component is used for supporting the part of the machine that turns around?

A. bearing

B. belt

C. gear

D. moving element

4. What is the name for something that can't be bent or deformed?

A. translational displacement

B. torque

C. rigid body

D. appreciable distortion

5. What term refers to a component of machinery that often consists of connecting sets of wheels with points?

A. belt

B. cam

C. gear

D. articulated joint

6. Which word refers to a branch of physics and subdivision of classical mechanics that deals with motion and forces involved?

A. physical motion

B. kinematics

C. action of forces

D. linkage

7. Which term describes a connection between two or more things?

A. linkage

B. cam

C. fluid

D. locomotion

8. What term refers to a force that causes something to rotate?

A. pivoting contact

B. torque

C. spring

D. resistant

9. What is the opposite of 'can be affected by something'?

A. equipped

B. arranged

C. pivoting

D. resistant

10. What adjective means the same as having a good knowledge of facts?

A. rich variety

B. negligible deformation

C. well grounded

D. equipped with smth.

29. ***Choose the option that best represents your skills, comprehension and involvement after finishing this unit to help you evaluate your learning experiences, highlight areas for improvement, and set goals for further improvement in your language skills.***

Areas	Statements	Choose the option
Participation	*I actively participated in class discussions and activities.*	***Yes / No / Partially***
Comprehension	*All the materials, ideas and concepts were easy to understand.*	***Yes / No / Partially***
Reading	*The text was easy to read and comprehend. Now I can read texts on relevant topics.*	***Yes / No / Partially***
Listening	*The listening task did not cause any difficulties. Everything was clear.*	***Yes / No / Partially***
Use of English	*I properly used terms and concepts to talk about robotics. I learned new words and word combinations and used them actively during the lessons.*	***Yes / No / Partially***
Speaking	*I did not have any challenges or hesitations in expressing myself. The topic easy and now I can discuss relevant ones.*	***Yes / No / Partially***
Collaboration	*In speaking activities or discussions, I effectively and actively cooperated with my peers.*	***Yes / No / Partially***
Writing	*My writing skills have improved, it was not a challenge for me to express my thoughts in a written way.*	***Yes / No / Partially***

Learning experience	*I think understanding mathematical concepts and topics introduced in the lesson improved my learning experience and contributed to my understanding of robotics.*	***Yes / No / Partially***

You didn't choose "Yes" for each statement? Don't worry! Turn

Areas for improvement	***Action plan***
Participation	*Try to invest in class discussions by asking questions and sharing your thoughts. If you don't feel confident enough to discuss the suggested topic, you can always ask your teacher about ways of improving your work during the lesson.*
Comprehension	*If it was difficult to understand the material in the unit, try to analyse what exactly was complicated, maybe you just need to translate some words or expressions. You can look up in the vocabulary appendix, or try one of the following strategies: use flashcards with translation or definition, write down new vocabulary, learn through media, learning from the context. Use can visit,* ***https://youglish.com/*** *an excellent resource that provides you fast, unbiased answers about how English is spoken by real people and in context.*
Reading	*Split the next into smaller parts and try to understand each one. Make a list of unknown words and expressions.*

Listening	*Focus on improving your listening comprehension by watching English-language media.*
Use of English	*Practice using new vocabulary in everyday conversation or writing. Look up the unknown words or phrases in the vocabulary appendix.*
Speaking	*Don't be afraid to make mistakes while speaking. Feel free to express your opinion even if you think it doesn't correlate with the opinions of others.*
Collaboration	*Aim to participate more actively in group work while working with the next unit. Form a study group with classmates to review concepts and support each other.*
Writing	*Write a plan for your writing piece. Make a list of words and phrases that you can use in your composition. Write a few ideas and try to elaborate on them.*
Learning experience	*Develop strategies to enhance your learning experience. Regularly revisit your learning goals and adapt your strategies as needed. Don't hesitate to ask for help from your teacher or classmates if you encounter difficulties.*

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What is reliability r

Unit 2

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APPENDIX 1. Vocabulary

Unit 1

AUTOMATION AND PROCESS CONTROL SYSTEMS

1.	accurate	*точний*
2.	actuator	*привідний механізм; актуатор*
3.	advancement	*прогрес; просування уперед*
4.	assembly line	*лінія збірки*
5.	automated manner	*автоматизованим способом*
6.	automation control	*автоматизований контроль*
7.	complexity	*складність*
8.	consistent and reliable performance	*послідовна та надійна продуктивність*
9.	core	*основа, ядро; основний*
10.	desired range	*бажаний діапазон*
11.	deviation	*відхилення (від курсу, маршруту, норми)*
12.	distributed control systems (DCS)	*розподілені системи керування (РСК)*
13.	feedback	*зворотній зв'язок*
14.	flow rate	*швидкість потоку*
15.	human error	*людський фактор*
16.	H V ^	*системи ОВК (опалення, вентиляції і кондиціонування)*
17.	increase productivity	*збільшувати продуктивність*

18.	industrial automation control	*контроль промислової автоматизації*
19.	industrial settings	*промислові налаштування*
20.	integration of sensors	*інтеграція датчиків*
21.	intervention	*втручання*
22.	level of sophistication	*рівень складності*
23.	machine learning algorithm	*алгоритм машинного навчання*
24.	manual intervention	*ручне втручання*
25.	manual labor	*ручна праця, фізична праця*
26.	manufacturing	*виробництво*
27.	precision	*точність*
28.	predefined rules	*заздалегідь визначені правила*
29.	pressure	*тиск*
30.	process automation control	*управління автоматизацією процесів*
31.	production line	*виробнича лінія*
32.	programmable logic controllers (PLCs)	*програмовані логічні контролери*
33.	quality control	*контроль якості*
34.	reliability	*надійність*
35.	thresholds	*граничні значення, пороги*
36.	to adjust	*регулювати, налаштовувати*
37.	to collect data	*збирати дані*
38.	to depend (on)	*залежати від*
	human error	*усувати людську помилку*
40.	to ensure	*забезпечувати, гарантувати*
41.	to execute actions	*виконувати, здійснювати дії*
	incorporate	*включати, об'єднувати*

43.	to involve	*залучати, включати в себе*
44.	to make decisions	*приймати рішення*
45.	to measure	*вимірювати*
46.	to monitor	*контролювати*
47.	to pave the way	*прокладати шлях*
48.	to range (from)	*коливатися (від)*
49.	to reduce costs	*зменшити витрати*
50.	to regulate processes	*регулювати процеси*
	rely (on)	*покладатися на*
		приводити в дію механізм
53.	to utilize	*використовувати*
54.	wide range of industries	*широкий спектр галузей*
55.	workflows	*робочі процеси*

Unit 2

SENSORS, ACTUATORS, CONTROLLERS

		двигун змінного струму
2.	acceleration	*прискорення*
3.	aircraft flight control system	*система управління польотом літака*
4.	a :	*аналоговий сигнал*
		поведінка динамічних систем
6.	capacitive	*ємнісний*
7.	comb drive	*гребінчастий привод*
8.	condition-based maintenance	*технічне обслуговування за потреби*
9.	control system	*система керування (регулювання)*
10.	controlled value	*контрольоване значення*
11.	electrical pulse	*електричний імпульс*
12.	electrical voltage	*електрична напруга*
13.	electronics circuit	*електронна схема*
14.	embedded	*вбудований*
15.	home automation system	*система домашньої автоматизації*
16.	hydraulic cylinder	*гідравлічний циліндр*
17.	hydraulic fluid	*гідравлічна рідина*
18.	hydraulic pressure	*гідравлічний тиск*
19.	input ports	*вхідні порти*
20.	IoT device	*пристрій інтернету речей*
21.	load	*навантаження*

22.	mediator	*посередник*
23.	nuclear reactor	*ядерний реактор*
24.	output ports	*вихідні порти*
25.	physical environment	*фізичне середовище*
26.	pneumatic pressure	*пневматичний тиск*
27.	power	*потужність*
		попередньо встановлений
29.	process control systems	*системи управління процесами*
30.	properties	*властивості*
31.	real-life applications	*практичні застосування*
32.	required value	*необхідне значення*
33.	resistive surface	*опорна поверхня*
34.	sensing element	*чутливий елемент*
35.	servo motor	*серводвигун*
36.	set value (SV)	*встановлене значення*
37.	signal processing unit	*блок обробки сигналів*
38.	stepper motor	*кроковий двигун*
39.	temperature variations	*коливання температури*
40.	thermostat's thermistor	*регулятор термостата*
	accommodate	*розмістити, пристосувати*
		досягнути бажаних результатів
		змішувати
	compare	*порівнювати*
45.	to convert	*перетворювати*
		виявити
47.	to facilitate	*сприяти, полегшувати*
		генерувати рух

		тлумачити
50.	to modulate the power	*змінювати, моделювати потужність*
51.	to provide feedback	*забезпечувати зворотній зв'язок*
		відбивати
53.	to sense	*визначати, вимірювати (параметри)*
54.	transduction element	*елемент трансдукції*
55.	voltage	*напруга*

Unit 3

SOFTWARE FOR CONTROL SYSTEMS

		аналіз зони охоплення застосунку
		централізоване зберігання бази даних
		складний процес роботи над розробкою
		складні промислові процеси
		об'єднання, зміцнення, укрупнення
		безперервний час
		ланцюг системи керування
		програмне забезпечення системи керування
		такий, що можна пристосовувати (систему для її відповідності конкретному застосуванню)
		процес проектування
		розробка настільного програмного забезпечення
12.	diagramming tool	*інструменти діаграми*
		різноманітна концепція дизайну
		вбудовані програмні засоби
		система інженерного розрахунку
		інтеграція систем підприємства
		особливість, риса
		промислові об'єкти
		властивий

		інтегрований, комплексний застосунок
		лінійна система
22.		*підтримувати бажаний рівень продуктивності*
		математичне рівняння
		багато доменні динамічні системи
		закономірно підходить
		нелінійна система
		попередньо налаштовані блоки
		попередні знання, досвід
29.	principal interface	*головний інтерфейс*
		відстеження продуктивності
		програмоване логічне керування
		в режимі реального часу
		контрольний зразок
		віддалений доступ
		панель інструментів роботизованої системи
		вибірковий час
		злегка
		надійність програмного забезпечення
		швидко
	within the system	*налаштовувати, регулювати компоненти у межах системи*
	a calculation system	*обирати, впроваджувати систему обчислення*
		автоматизувати контроль

	e	*стимулювати попит*
		згенерувати вихідні дані
45.	to incorporate	*включати в себе*
		обробляти дані
	… to)	*коливатися (від ... до)*
		прискорювати процеси
		допустимість похибки
		критерії відслідковування
		клапан
		віртуальні прототипи
		обсяг
		програмне забезпечення веб-застосунків
55.	w ;	*з мінімальними зусиллями*

Unit 4

COMPUTER INDUSTRIAL NETWORKS

		аутентифікація; розпізнання
		розширена інформація
		автоматизовані засоби
		шинний кабель
		мережі зв'язку
		протокол зв'язку
		сумісний
		складна установка
		комп'ютерні промислові мережі
		мідь
		збирання даних
		обмін даними
		де факто, фактично
		децентралізовані польові пристрої
		визначений
		недолік
		електричні інтерфейси
		кодувальник
		обладнання
		галузі автоматизації виробництва
		волокно
		польові шини
		сумісний

		верстати
	master – slave relationship	*модель «ведучий – ведений»*
		вимірювальний прилад
		середовище передачі даних
		мережевий кабель
		підключення до мережі
		навантаження на мережу
		патч-кабелі
		патч-панелі
	p h	*фізичний рівень*
		установка управління процесами
		оригінальний дизайн
		реле
		відповідальний (за)
		ризики пов'язані з безпекою
		послідовні лінії
		значно
		стандартний протокол зв'язку
	T C	*TCP / IP стек*
		чутливі до часу програми
		обмінюватись даними
		прискорювати обмін даними
		реалізувати, впроваджувати
		оптимізувати
		посилатися (на)
		вимагати
		означати

		передавати дані
		передача
		однонаправлений контроль
		універсальний
		бездротові мережеві технології

Unit 5

MATHEMATICAL MODELING

		алгебраїчне співвідношення
		поведінка
	defined	*широко визначений*
		розрахунки, обчислення
		загальні терміни
		складний
		склад
		залежна змінна
		диференціальні рівняння
		величини
		дискретний
		відмінні значення
		система розподілених параметрів
		емпіричні дані
		рівняння
		зовнішні впливи
		примусові функції
		формулювання
		функціональний зв'язок
		загальний сенс
		незалежна змінна
		лінійні диференціальні рівняння
		системи зосереджених параметрів

		математичний вираз
	m	*математичне моделювання*
		математичне представлення
		значущі символи
		відповідати нормам безпеки
		удосконалення моделі
		нелінійні диференціальні рівняння
	numerical method	*метод підбирання*
		звичайні диференціальні рівняння
		рівняння в частинних похідних
		фізична система
		передбачення
		раніше, попередньо
		сценарій реального світу
		уточнення
		такий, що відображає
		актуальні
		послідовний
		просторово розподілені
		етап
		зацікавлені сторони
		стан
		суперпозиція
		властивості системи
		оцінювати
		представляти
		керувати

		надати розуміння
		відбивати
		представляти реалії
		спростити
		перевірка

Unit 6

DATA VISUALIZATION

		вправність (у), уміння (в) чомусь
		відповідний
		діаграма з областями, просторова діаграма
		вісь
		гістограма
		поведінкові дані
	b	*бульбашкова діаграма*
	chart	*діаграма*
		стовпчик
	i	*коротко, стисло*
		заплутана статистика
		візуалізація даних
		отримати аналітичну інформацію
		різні джерела
		результати, що легко розрізнити
		оцінювання
		теплова карта
		ієрархічні дані
		гістограма
		ефективний, дієвий інструмент
	world	*світ, що наповнений інформацією*
	m	*змістовна, конструктивна взаємодія*
		лінійна діаграма

		численні види
	particular range	*обмежений діапазон*
		шаблон
		кругова діаграма
		побудова серії точок даних
		слово-гібрид
		прогнозна аналітика
		попередня обробка
		прямокутник
		регресійний аналіз даних
		рядок
		точкова діаграма
		гістограма з накопиченням
		основний продукт
		підходящий
		оцінювати
		привернути увагу
		порівнювати змінні величини
		передавати складні ідеї
		відображати, зображати інформацію
		покращувати розуміння
		виявляти викиди (значення, що сильно відхиляються)
		інтерпретувати аналітичну інформацію
		досягати цілей
		розкрити відношення

		стекувати змінні
		деревовидна карта
		тенденція
	u	*нецікава, незахоплююча статистика*
		наочне приладдя, наочність
		візуальні уявлення
		техніки візуалізації

Unit 7

BASICS OF ROBOTICS

		дія сил
		вдосконалені / модернізовані сенсори
		значна /помітна деформація
		розташований в певному порядку
	joint	*шарнірне з'єднання*
		підшипник
		ремінь
		кулачок
		деформація
	y	*пружне тіло*
		обладнаний чимось
		фіксована вісь
		речовина з властивостями рідини і газу
		шестерня
	higher kinematic pair	*вища кінематична пара*
		шарнір
		нерухоме сполучення
		кінематика
		ланка
		пересування
	l 2	*нижча кінематична пара*
		зуб'я, що перебувають у зчепленні
		рухомий елемент

		багатокорпусна система
		незначна деформація
		фізичний рух
		поворотний контакт
		потенційний рух
		найпростіші сполучення
		призматичне з'єднання
		відносний рух
		відносно оточення
		стійкий
		поворотне з'єднання
		революційні творіння
		багата різноманітність
		жорстке тіло
	robot's joint coordinated	*координований суглоб робота*
		обертове з'єднання
	set of machine elements	*набір елементів машини*
		вал
		ковзне з'єднання
		просторове планування
		пружина
		спричиняти рух
		змінити стан навколишнього середовища
		змінювати форму, деформуватися
		попередньо тренуватися
		обертатися
		зазнавати деформації

		передавати рух
		крутний момент
		поступальне зміщення
		під дією сил
		добре обізнаний в інженерному проектуванні

APPENDIX 2. Audioscripts

Unit 1

AUTOMATION AND PROCESS CONTROL SYSTEMS

Unit 2

SENSORS, ACTUATORS, CONTROLLERS

Unit 3

SOFTWARE FOR CONTROL SYSTEMS

"So what is a PID controller? It is an acronym that stands for Proportional

should be. These usually come in the form of sensors and meters. PIDs come in many different forms including standalone units and PLC programming. We can use our input and output cards along with programming software to set up a PID."

Unit 4

COMPUTER INDUSTRIAL NETWORKS

The Benefits of Using Single Pair Ethernet for Industrial Automation

Unit 5

MATHEMATICAL MODELING

Mathematical Modeling: Energy Balances

Unit 6

DATA VISUALIZATION

Unit 7

BASICS OF ROBOTICS

APPENDIX 3. Guidelines for Writing

Writing a report usually involves presenting your analysis or view, highlighting key findings or insights, and summarizing the main points. The general guidelines for organizing and writing a report are provided below:

- ✓ Organize information logically by following the pattern: introduction - body - conclusion.
- ✓ Provide the information in a manner that is understandable, clear, and concise.
- ✓ Use linking words and phrases to connect the paragraphs.
- ✓ Start by explaining the purpose of your report and how the information is relevant.
- ✓ Write your main argument(s). Provide evidence and examples to support your main points.
- ✓ Summarize the main points, and highlight the key findings or insights.
- ✓ Review your writing for spelling, grammatical, and punctuation mistakes.
- ✓ Make sure to cite the examined sources properly.

For more information, please visit ***10 Tips for Perfect Report Writing***

Writing a manual usually involves presenting instructions or information for users to understand products or procedures. The general guidelines for organizing and writing a manual are provided below:

- ✓ Outline the manual structure. Organise information in a logical hierarchical manner.

✓ Your writing should be clear and easy to comprehend. Write in short sentences to make it more understandable. Make sure to define any technical terms you must use or include a link to a glossary.

✓ Include visuals, such as diagrams, charts, and videos to help the users and make information in the manual more accessible.

✓ Consider the users are non-specialists. Don't forget to explain icons, symbols, etc.

✓ Review your writing for spelling, grammatical, and punctuation mistakes.

✓ Make sure to cite the examined sources properly.

For more information, please visit ***Ultimate Guide to write instruction for User Manual***

Writing an essay includes the key elements, such as understanding the topic, creating a draft, and improving and reviewing your final version. The general guidelines for structuring and writing an essay are provided below:

✓ Make sure you understand the instructions and topic or question of the essay.

✓ Research on the subject to gain relevant information as well as references for your arguments.

✓ Use evidence to build and support your main argument.

✓ Organize your essay coherently, including the main components: introduction - body - conclusion.

✓ Provide the information in a manner that is understandable, clear and concise.

✓ Use linking words and phrases to connect the paragraphs.

✓ In introduction present the main argument or statement, provide the background information.

✓ Write a body of your essay, including the main points, examples, evidence and names and quotations and citations from the sources.

✓ Summarize the key points, restate your main argument, write a concluding statements.

✓ Review your writing for spelling, grammatical, and punctuation mistakes.

✓ Make sure to cite the used sources properly.

For more information, please visit ***Writing a great essay***

Writing a review involves the evaluation of different aspects of what is reviewed, for example case study. The general guidelines for structuring and writing a review are provided below:

✓ Take time to examine the case entirely and note key details, examples, etc.

✓ Identify the main ideas and area of interest: problems and issues in the case.

✓ Identify areas for improvement and all possible solutions to the problems in the case.

✓ Arrange information into several sections: introduction - body - conclusion.

✓ Provide the information in a manner that is understandable, clear, and concise.

✓ Use linking words and phrases to connect the paragraphs.

✓ Begin by introducing a case within the context, purpose, and background information.

✓ In the main body review the key findings, explain the evaluation criteria, and provide examples. Write about the strengths and weaknesses of the case with examples or evidence if possible.

✓ In conclusion, sum up the main ideas, and overall evaluation of the case, and restate your main findings.

✓ Review your writing for spelling, grammatical, and punctuation mistakes.

For more information, please visit ***Need help with writing a case study analysis?***

In writing a blog post the key elements, such as catchy title, topic relevance, engagement, and flow. The general guidelines for structuring and writing a blog post are provided below:

✓ Begin by creating an attention-grabbing title to engage your audience and give the idea of what is the post about.

✓ Clearly state the subject of the post and your point of view on it.

✓ Support your main points with evidence such as quotes, statistics, etc.

✓ Outline your content logically to guide your audience through your thoughts.

✓ Use a clear layout with headings and subheadings for easy navigation.

✓ Provide the information in a manner that is understandable, clear, and concise.

✓ Use linking words and phrases to connect the paragraphs.

✓ Review your writing for spelling, grammatical, and punctuation mistakes.

✓ Make sure to cite the used sources properly.

For more information, please visit ***How to Write a Blog Post in 10 Steps***

Writing a summary of an article usually sets the goal to provide a concise and precise representation of the article's content and the key points. The general guidelines for organizing and writing a summary of an article are provided below:

- ✓ Read the article entirely and note key details, dates, examples, etc.
- ✓ Identify the main ideas and areas of interest.
- ✓ Arrange information into several sections: introduction - body - conclusion.
- ✓ on the supporting evidence, such as data, facts, or other details that provide context for the main ideas.
- ✓ Write your summary, including main idea, supporting evidence, relevant events or people.
- ✓ Review your summary for spelling, grammatical, and punctuation mistakes and edit if necessary.

For more information, please visit ***How to Summarize an article***

Writing a tutorial includes key elements such as clear objectives, organized structure, relevant visuals, engaging content, real-world examples and effective tips. The general guidelines for structuring and writing a tutorial are provided below:

- ✓ Make sure you understand the needs, interests of your target audience and their level of knowledge.
- ✓ Clearly state the purpose of your tutorial. What do you expect your audience to learn from it?
- ✓ Maintain clear and logical structure to increase readability and guide your reader though the content.
- ✓ Include relevant visuals, such as charts, graphs, diagrams, etc. to illustrate the concepts and enhance clarity and understanding.

- ✓ Include real-world examples to illustrate the relevance of the concepts in particular spheres of life.
- ✓ Share a few tips or tricks that can engage the audience and be extremely useful.
- ✓ Provide the information in a manner that is understandable, clear, and concise.
- ✓ Use linking words and phrases to connect the paragraphs.
- ✓ Review your writing for spelling, grammatical, and punctuation mistakes.
- ✓ Make sure to cite the used sources properly.

For more information, please visit ***Writing Tutorials – 11 Essential Tips To Crafting The Ultimate Tutorial***

APPENDIX 4. Self-Assessment Keys

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
A	C	D	C	B	D	A	A	B	A

Sensors, Actuators, Controllers

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
B	A	C	B	A	D	C	B	A	A

Software for Control Systems

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
A	A	C	C	A	B	D	B	A	C

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
A	C	A	D	C	B	B	A	D	A

Mathematical Modeling

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
B	**A**	**C**	**A**	**B**	**D**	**A**	**B**	**C**	**B**

Data Visualization

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
B	**A**	**A**	**C**	**B**	**D**	**D**	**D**	**A**	**B**

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
D	**A**	**A**	**C**	**C**	**B**	**A**	**B**	**D**	**C**