МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ
імені В. Н. КАРАЗІНА

ІНОЗЕМНА МОВА ПРОФЕСІЙНО-ДІЛОВОГО СПІЛКУВАННЯ АНГЛІЙСЬКА МОВА

Методичні вказівки до проведення практичної роботи
для здобувачів першого (бакалаврського) рівня вищої освіти 3-4 курсів
денної та заочної форми навчання за спеціальністю 174
«Автоматизація, комп’ютерно-інтегровані технології та робототехніка»

Електронний ресурс

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І-67 **Іноземна** мова професійно-ділового спілкування. Англійська мова : методичні вказівки до проведення практичної роботи для здобувачів першого (бакалаврського) рівня вищої освіти 3-4 курсів денної та заочної форми навчання за спеціальністю 174 «Автоматизація, комп'ютерно-інтегровані технології та робототехніка» [Електронний ресурс] / укладачі: О. В. Бринцева, А. О. Подорожна. – Харків : ХНУ імені В. Н. Каразіна, 2025. – (PDF 73 с.)

Методичні вказівки до проведення практичної роботи з дисципліни «Іноземна мова професійно-ділового спілкування. Англійська мова» акцентують увагу на важливості застосування англійської мови у професійному спілкуванні, що особливо актуально в умовах глобалізації та необхідності інтеграції в міжнародні наукові та інженерні спільноти. Вони сприяють формуванню здатності до аргументованого і логічного викладу думок як в усній, так і в письмовій формі, що є необхідним для інженерів та фахівців, що працюють в умовах глобальних технологічних змін.

Видання призначене здобувачам першого (бакалаврського) рівня вищої освіти 3-4 курсів денної та заочної форми здобуття освіти за напрямом підготовки 174 «Автоматизація, комп'ютерно-інтегровані технології та робототехніка».

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ВСТУП

Подані методичні матеріали призначені для проведення практичних занять для здобувачів освіти освітнього ступеню «бакалавр» 3-4 курсів денної та заочної форми навчання спеціальності 074 Автоматизація, комп’ютерно-інтегровані технології та робототехніка та ставлять за мету формування та розвиток професійних мовних і комунікативних компетенції у студентів. Тематика методичних рекомендацій обрана згідно із загальноєвропейськими вимогами щодо професійно-орієнтованого підходу до навчання іноземній мові у вищих навчальних закладах і відповідає головним напрямам науково-дослідницької діяльності навчального закладу.

Методичні матеріали складаються з 7 розділів і мають однакову структуру, що віддзеркалює майже всі складові навчальної дисципліни. Стрижнем кожного розділу є автентичний текст для читання, перекладу і виконання вправ на розуміння його змісту. Усі лексичні вправи мають комунікативну спрямованість та націлені на закріплення активного вокабуляру під час виконання комунікативних завдань, на розвиток комунікативної компетенції із застосуванням фахової термінології.

Кожен із розділів містить завдання на формування та розвиток навичок письмового спілкування студентів, які мають творчий характер та є корисними для розвитку критичного мислення, самовираження та вміння аргументувати свою точку зору. Завдяки таким завданням студенти здобувають навички, які допомагають їм не лише в академічному письмі, а й у професійному та повсякденному житті.

У процесі засвоєння даного курсу у студентів формуватимуться вміння аналізувати професійну літературу, виконувати переклади технічних текстів, застосовувати відповідну термінологію в усних та письмових комунікаціях, а також ефективно презентувати результати своїх досліджень та проектів. Крім того, студенти навчаться орієнтуватися в специфічних аспектах міжнародної технічної комунікації, враховуючи культурні та мовні відмінності.

Успішне засвоєння матеріалу допоможе здобувачам освіти не лише покращити рівень володіння іноземною мовою, а й підвищити свою конкурентоспроможність на ринку праці, оскільки набуті навички писемного та усного спілкування з використанням професійної термінології є важливими для успішної кар'єри в сфері автоматизації, комп'ютерно-інтегрованих технологій та робототехніки.

Методичні матеріали орієнтовані на формування у студентів здатності працювати з автентичними джерелами інформації, самостійно виконувати завдання, а також на ефективну інтеграцію знань з іноземної мови в їх професійну діяльність. Усі вправи й завдання є спрямованими на інтерактивний підхід до навчання, що дозволяє студентам активно взаємодіяти з матеріалом і забезпечує практичне застосування отриманих знань у реальних ситуаціях.

UNIT 1

AUTOMATED PROCESS CONTROL SYSTEMS

Task 1. ***Read and translate the following text.***

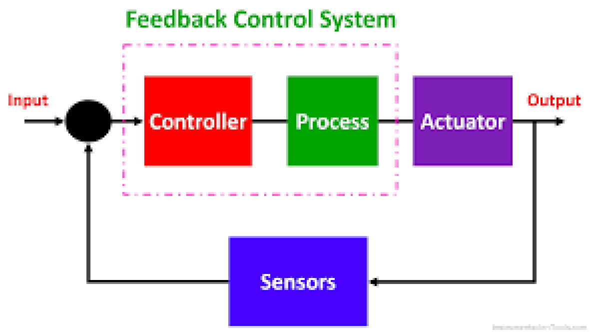
Automated Process Control Systems

Automated Process Control Systems (APCS) are integral to modern industrial operations, playing a critical role in managing complex processes that require precise control to ensure consistent quality, safety, and efficiency. These systems are widely used across industries such as manufacturing, petrochemicals, pharmaceuticals, food processing, energy production, and more, where maintaining optimal performance is essential for achieving desired outcomes. At their core, APCS use advanced technologies to monitor, control, and adjust various process variables, such as temperature, pressure, flow rate, and chemical concentrations. By continuously collecting real-time data from sensors and using sophisticated algorithms, APCS make real-time decisions to adjust processes, ensuring that they stay within desired parameters and meet production goals. The growing demand for higher efficiency, reduced operational costs, enhanced safety, and improved product quality has driven the widespread adoption of APCS. These systems not only optimize the processes but also provide valuable insights through data analysis, predictive maintenance, and regulatory compliance.

In this context, APCS are evolving rapidly, incorporating advanced strategies like Model Predictive Control (MPC), adaptive control, and machine learning to handle increasingly complex and dynamic processes. As industries continue to embrace automation and digitalization, APCS are expected to play a pivotal role in the future of industrial operations, contributing to greater innovation, sustainability, and competitiveness.

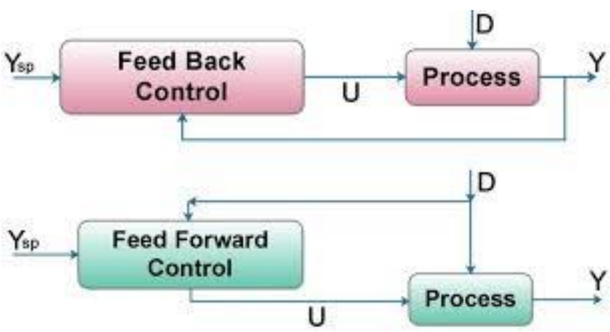
Key Types of APCS

Feedback Control Systems.



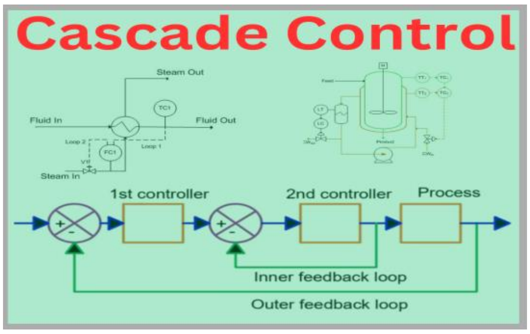
These systems continuously monitor the output of the process and compare it with the desired setpoint (target value). The controller adjusts the input to bring the process output back to the setpoint. Example: A temperature control system in a furnace might adjust the burner’s heat based on the real-time temperature measurements.

1. *Feedforward Control Systems.*



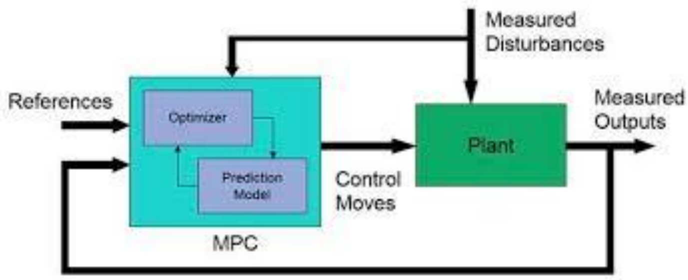
These systems make adjustments based on the input or disturbances affecting the process before they impact the output. This type of control is used when the effects of disturbances can be predicted. *Example:* In a chemical reactor, if the flow rate of a reactant changes, the feedforward controller adjusts the other variables to maintain the desired product concentration.

2. *Cascade Control Systems.*



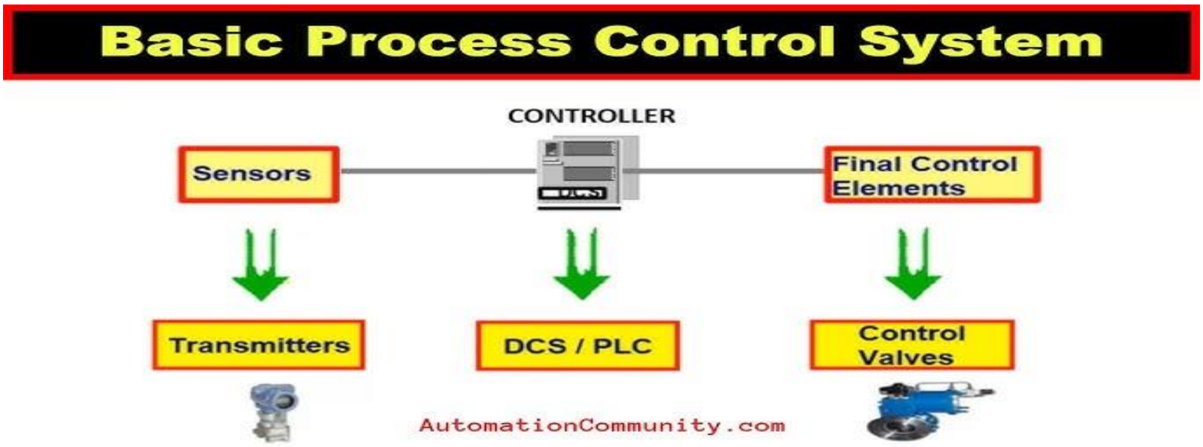
Cascade systems use multiple controllers, where the output of one controller serves as the setpoint for another. This improves the overall system's stability and performance by handling more complex processes. *Example:* A temperature control system might use a primary controller for the temperature setpoint and a secondary controller for controlling a specific heating element.

3. *Model Predictive Control (MPC).*



MPC is a more advanced control method that uses a mathematical model of the process to predict future outputs and optimize control actions over a given time horizon. It is used in processes where time delays and constraints are significant factors. *Example:* MPC is commonly applied in the oil refining industry for managing the various dynamic and interacting variables involved in refining processes.

Components of Automated Process Control Systems



1. Sensors gather real-time data on the process variables. They are responsible for measuring physical quantities such as temperature, pressure, flow rate, and chemical concentrations. These sensors convert the physical measurements into electrical signals that can be processed by controllers. Example: Temperature sensors (thermocouples, RTDs) for measuring heat, pressure sensors for monitoring pressurized systems, or flow meters for controlling fluid movement.

2. The controller is the brain of the APCS. It compares the actual values (measured by the sensors) to the desired setpoints and computes the necessary adjustments to control the process. The most common type of controller is the PID (Proportional-Integral-Derivative) controller, which adjusts the control output by considering the proportional error (difference between setpoint and actual), the integral of past errors (cumulative error), and the derivative (rate of change of error). Example: In an HVAC system, a PID controller regulates the airflow and heating/cooling based on the temperature setpoint.

3. *Actuators* are devices that respond to control signals from the controller and physically alter the process. These can include valves, pumps, motors, and dampers. Example: In a pump system, actuators control the flow rate by adjusting the speed of the pump in response to control signals from the controller.

4. Human-Machine Interface (HMI). The HMI provides a graphical interface that allows operators to interact with the control system. It displays real-time data, trends, and alerts, and enables operators to manually override automated controls when necessary. Example: The HMI might display a graph of temperature over time and allow an operator to adjust settings if the system is trending outside the desired range.

Control Strategies

1. The PID controller is the most common and widely used control strategy. It works by calculating the error value (difference between the desired setpoint and actual value) and applying corrective actions based on three terms:

- Proportional. The error value itself.
- Integral. The cumulative sum of past errors.
- Derivative. The rate of change of error.
- Tuning a PID controller involves setting the correct weights for these three components to achieve the desired system response.

2. Adaptive control systems adjust their control parameters in real-time based on the changing behavior of the process. This is useful in systems where the process characteristics change over time. Example: An adaptive control system in a chemical plant might adjust control parameters as the chemical composition of raw materials varies.

3. Fuzzy Logic Control. Fuzzy logic controllers are used in situations where the process is difficult to model mathematically. They mimic human decision-making by using linguistic variables (such as "high," "medium," "low") and fuzzy sets to make decisions. Example: In an automated car wash system, fuzzy logic may determine the optimal pressure and duration of water spray based on the dirtiness of the car.

4. Distributed Control Systems (DCS). In a DCS, control actions are distributed across various controllers within the plant rather than being handled by a single

central unit. Each unit controls a specific portion of the process. Example: In large-scale power plants, DCS can manage different subsystems such as turbines, boilers, and cooling systems independently while ensuring the overall system operates smoothly.

5. Programmable Logic Controllers (PLC). PLCs are used to automate discrete processes (on/off control) and are often programmed with ladder logic or other programming languages. They are essential in industries where sequential control or logic-based decision-making is needed. Example: A PLC might control a bottling line, ensuring bottles are filled, capped, and labeled in the correct sequence.

Benefits of APCS

Automated systems can optimize processes, reduce waste, and minimize energy consumption by continuously adjusting to changing conditions. Automation helps maintain consistent product quality by minimizing human errors and ensuring precise control over variables such as temperature and pressure. By continuously monitoring processes and intervening when necessary, APCS can prevent hazardous conditions and protect both personnel and equipment from failure or dangerous situations.

APCS reduce the need for manual intervention, decrease downtime, and increase throughput, leading to lower operational costs. Automated systems gather large amounts of data, which can be analyzed for process optimization, predictive maintenance, and long-term improvements.

Challenges:

Designing and maintaining complex APCS can be challenging, particularly for large, integrated systems. Proper configuration and tuning are required for optimal performance. The cost of setting up automated systems, including sensors, controllers, and software, can be high, though the long-term benefits often outweigh the costs. As APCS become more connected, particularly with the rise of Industry 4.0

and the Industrial Internet of Things (IIoT), cybersecurity concerns increase, requiring robust protection against cyber threats.

VOCABULARY

Automated Process Control Systems (APCS) Автоматизовані системи управління технологічними процесами (АСУ ТП)

Feedback Control Systems Системи керування зі зворотним зв'язком

Feedforward Control Systems Системи керування з прямим зв'язком

Cascade Control Systems Каскадні системи керування

Model Predictive Control (MPC) Модельне прогнозуюче керування (MPC)

Sensors Датчики

Controllers Контролери

PID Controller (Proportional-Integral-Derivative) PID-регулятор (пропорційно-інтегрально-похідний)

Actuators Приводи

Human-Machine Interface (HMI) Людино-машинний інтерфейс (HMI)

Control Strategies Стратегії управління

Adaptive Control Адаптивне керування

Fuzzy Logic Control Керування на основі нечіткої логіки

Distributed Control Systems (DCS) Розподілені системи управління (DCS)

Programmable Logic Controllers (PLC) Програмовані логічні контролери (ПЛК)

Efficiency Ефективність

Quality Control Контроль якості

Safety Безпека

Cost Savings Економія витрат

Data Collection and Analysis Збір та аналіз даних

System Complexity Складність системи

Initial Investment Початкові інвестиції

Cybersecurity Кібербезпека

Industry 4.0 Індустрія 4.0

Industrial Internet of Things (IIoT) Промисловий Інтернет речей (IIoT)

Task 2. ***Match the term with its correct description.***

Automated Process Control Systems (APCS)
PID Controller (Proportional-Integral-Derivative)
Model Predictive Control (MPC)
Fuzzy Logic Control
Human-Machine Interface (HMI)
Distributed Control Systems (DCS)

1. A type of control system that uses a mathematical model to predict and optimize future outputs. ___________________
2. A system that uses linguistic variables like "high" and "low" to make decisions in uncertain environments._____________________
3. A system that allows operators to interact with and monitor process variables in real-time._________________________
4. A system where control actions are distributed across various controllers to manage different parts of a process._____________________
5. A control system that calculates corrective actions based on three components: proportional, integral, and derivative._________________
6. A system that automates and monitors processes in industries such as manufacturing and energy. _______________________

Task 3. ***Complete the sentences with the correct term.***

1. ________ control systems continuously monitor the process and adjust inputs to maintain the desired output.
2. ________ controllers are often used in automated systems to control variables such as temperature, pressure, and flow.
3. ________ control strategies allow the system to adjust its parameters in response to changes in process behavior.
4. In a ________ system, the output of one controller serves as the setpoint for another controller.
5. ________ control is used when the effects of disturbances can be predicted and adjustments are made before they affect the system.
6. The ________ is responsible for physically altering the process by controlling elements like valves, pumps, or motors.

Task 4. ***Answer the questions according to the text.***

1. What industries benefit from Automated Process Control Systems (APCS), and why are these systems important in these industries?

____

2. Explain how Feedback Control Systems work and provide an example of where this type of control system might be used.

____

3. What distinguishes Feedforward Control Systems from Feedback Control Systems? Can you give an example where a Feedforward Control System would be preferred?

____

4. Describe Cascade Control Systems. How do they improve process control, and what is a real-world example of their application?

____

5. What is Model Predictive Control (MPC), and in which industries is it commonly applied?

____

6. List the main components of an Automated Process Control System (APCS) and explain the role of each component.

____

7. What are the different types of sensors used in APCS, and what variables do they measure? Provide examples of how they work.

____

8. Describe the function of the controller in an APCS. How does a PID controller operate, and what are the three components that make it work?

____

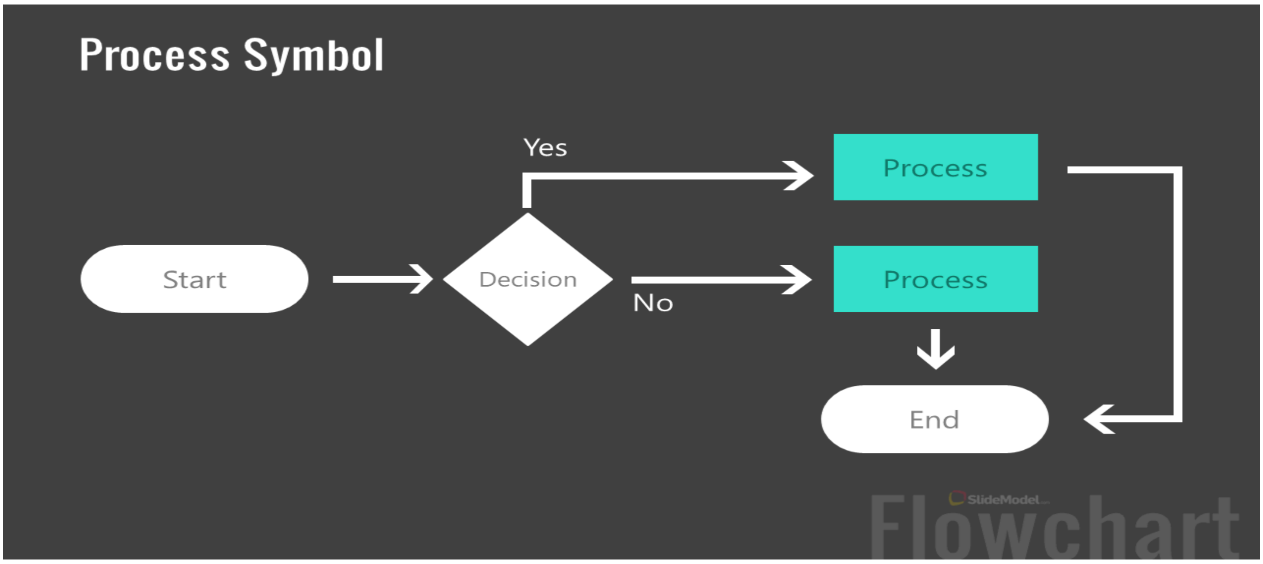
9. What are actuators, and how do they interact with controllers in an Automated Process Control System? Provide an example.

____

10. Explain the purpose and function of the Human-Machine Interface (HMI) in an APCS. How does it benefit operators?

____

Task 5. ***Diagram/Flowchart***



1. Draw a flowchart or diagram showing how an Automated Process Control System (APCS) works. Include the components: Sensors, Controller, Actuators, and Human-Machine Interface (HMI).

Show how data flows through the system from input (sensors) to output (actuators) and how the controller processes the information.

2. Create a flowchart that distinguishes between Feedback Control Systems and Feedforward Control Systems. Include examples of where each would be applied.

Task 6. ***Challenge Task: System Design***

Design an APCS for a temperature control system in a chemical reactor where precise temperature control is crucial to ensure product quality.

1. Which control strategy would you choose (Feedback, Feedforward, or MPC)? Justify your choice.
2. Identify the sensors, controllers, actuators, and HMIs that would be required for this system.
3. Explain how the system would respond if a sudden temperature fluctuation occurs due to an external disturbance.
4. What benefits would this APCS bring to the chemical plant?

UNIT 2

FUTURE OF AUTOMATED PROCESS CONTROL SYSTEMS

Task 1. ***Read and translate the following text.***

The future of Automated Process Control Systems (APCS) is expected to be shaped by technological advancements, the integration of new concepts, and the evolving needs of industries. Below are some key trends and developments that will likely define the future of APCS.

Integration with Industry 4.0 and Industrial Internet of Things (IIoT).

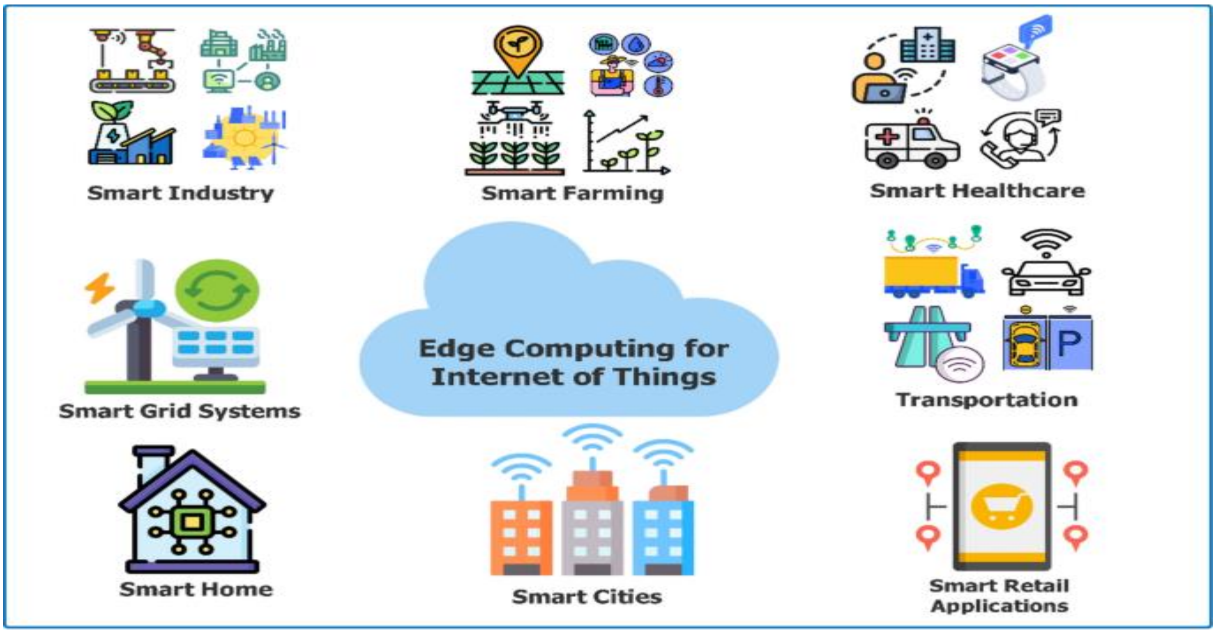
As part of Industry 4.0, APCS will increasingly integrate with IIoT, where sensors, actuators, and controllers are interconnected via cloud platforms, enabling real-time monitoring, analysis, and decision-making. Future APCS will enable "smart factories" where machines, equipment, and systems can communicate with each other autonomously, optimize processes, and adapt to changing conditions without requiring human intervention. Cloud computing and 5G networks will enable remote monitoring and control of processes, allowing operators to manage systems from anywhere in the world, increasing flexibility and responsiveness.

Artificial Intelligence (AI) and Machine Learning (ML) Integration.

AI and ML will play a significant role in analyzing the vast amounts of data generated by APCS. This data will be used for predictive maintenance, anomaly detection, and process optimization, leading to reduced downtime and increased efficiency. AI-based systems will enhance adaptive control, enabling APCS to automatically adjust control parameters based on real-time data, improving the system's ability to handle dynamic and complex environments. Future systems will be capable of "self-learning" from historical data, improving their performance and adapting to new conditions without manual reprogramming.

Increased Use of Model Predictive Control (MPC). MPC will continue to be at the forefront of advanced control strategies, particularly for processes with multiple variables and time delays. MPC will be used more widely across industries such as oil refining, chemicals, and energy production, where precise control of complex systems is critical. As sensors and IIoT technologies evolve, MPC will leverage real-time data and predictive models to optimize operations across various time horizons, improving both short-term and long-term decision-making.

Edge Computing for Real-Time Control.



Edge computing will allow data processing to occur closer to where the data is generated (i.e., at the "edge" of the network), reducing latency and enabling real-time decision-making. This is particularly useful for time-sensitive operations, where instant responses are necessary for maintaining safety and efficiency. With edge computing, only critical data or aggregated information needs to be sent to central systems, reducing the demand on communication networks and allowing for faster response times.

Cybersecurity and Data Privacy.

As APCS become more interconnected and rely heavily on data from IIoT devices, cybersecurity will be a major focus. Future systems will implement more advanced encryption, authentication, and intrusion detection systems to protect against cyber threats. Systems will be designed with resilience in mind, incorporating fail-safes and redundancy to ensure that they can continue to operate even in the event of a cyberattack or data breach.

Human-Machine Collaboration. Augmented Reality (AR) and Virtual Reality (VR): The integration of AR/VR with HMI systems will provide operators with immersive, intuitive control and visualization tools. This will allow operators to interact with the system in new ways, enhancing their understanding and decision-making. While automation will continue to reduce the need for manual intervention, humans will still play a critical role in overseeing complex operations and making high-level decisions. Future APCS will be designed to work seamlessly with human operators, offering real-time support and decision guidance.

Sustainability and Energy Efficiency. APCS will play a pivotal role in helping industries achieve sustainability goals. By optimizing processes, reducing waste, and enhancing energy efficiency, these systems will help reduce the environmental footprint of manufacturing, chemical production, and other sectors. APCS will be integrated with energy management systems to monitor and optimize energy usage, further contributing to cost savings and sustainability.

Advanced Sensors and Data Acquisition. The development of more advanced sensors will allow APCS to monitor processes with greater accuracy and sensitivity. These sensors will provide higher-resolution data, enabling more precise control and optimization of processes. Future sensors will be able to measure multiple variables simultaneously (e.g., pressure, temperature, flow, and chemical composition), providing more comprehensive data for decision-making.

Flexible and Scalable Systems. APCS will become more modular and flexible, allowing companies to scale their systems up or down as needed. Modular design will enable easier updates and maintenance, ensuring that systems remain adaptable to changing production requirements. As industries continue to evolve, APCS will be tailored to specific needs, offering customized solutions for different sectors, processes, and production environments.

Autonomous and Self-Optimizing Systems. The future of APCS will see more processes becoming fully autonomous, with minimal human oversight. Self-optimizing systems will use real-time data and advanced algorithms to continuously improve performance and respond to changing conditions without human input. AI-driven algorithms will ensure that APCS continuously evolve, automatically adjusting to new conditions, identifying inefficiencies, and proposing solutions for improvement.

The future of Automated Process Control Systems will be heavily influenced by the integration of emerging technologies like AI, IIoT, and edge computing. The key focus will be on improving efficiency, adaptability, and security, while ensuring that systems remain scalable and flexible to meet the needs of industries. The evolution of APCS will not only enhance operational performance but also contribute to sustainability, cost savings, and safer work environments. As these systems become more intelligent and autonomous, their potential to revolutionize industries will continue to grow, offering new possibilities for innovation and optimization.

VOCABULARY

Industry 4.0 refers to the fourth industrial revolution, a term used to describe the transformation of manufacturing and industrial practices through the integration of advanced digital technologies. It marks a significant shift from traditional manufacturing processes to smart, automated, and interconnected systems, with a strong emphasis on data exchange, automation, and real-time decision-making

Industrial Internet of Things (IIoT) refers to the network of physical devices, machinery, sensors, and systems in industrial settings that are connected to the internet, enabling them to collect, exchange, and analyze data. It is an extension of the broader Internet of Things (IoT), but specifically tailored to industrial applications such as manufacturing, energy, transportation, healthcare, agriculture, and more.

Artificial Intelligence (AI) refers to the simulation of human intelligence processes by machines, particularly computer systems. It involves the development of algorithms, software, and hardware that enable machines to perform tasks that would normally require human intelligence, such as understanding natural language, recognizing patterns, solving problems, making decisions, and learning from experience.

Cybersecurity refers to the practice of protecting systems, networks, devices, and data from cyber threats, including attacks, unauthorized access, data breaches, and damage to digital assets. As the world becomes more digitally connected, cybersecurity has become increasingly vital to ensure the confidentiality, integrity, and availability of information and systems. The goal of cybersecurity is to prevent or minimize the risk of cyberattacks, data theft, and other harmful actions that could compromise digital infrastructure and sensitive data.

Augmented Reality (AR) is a technology that overlays digital information, such as images, sounds, or other data, onto the real world, enhancing the user's perception of their environment. Unlike Virtual Reality (VR), which creates a fully immersive, computer-generated environment, AR blends digital elements with the real world in real-time, allowing users to interact with both simultaneously.

Task 2. ***Fill in the Blanks.***

1. APCS will integrate with __________ as part of Industry 4.0 to enable real-time monitoring and decision-making.
2. __________ and __________ will play a significant role in analyzing the data generated by APCS for predictive maintenance and process optimization.
3. __________ computing will allow data processing at the "edge" of the network, reducing latency and enabling real-time decision-making.
4. Advanced __________ systems will be developed to provide higher-resolution data for more precise control and optimization.

5. APCS will increasingly integrate with __________ to help industries achieve sustainability and reduce their environmental footprint.

6. __________ Reality (AR) and __________ Reality (VR) will be integrated with HMI systems to offer immersive control and visualization tools.

7. The integration of APCS with IIoT will enable the development of __________ factories where machines communicate and optimize processes autonomously.

Task 3. ***Tick True or False***

1. The future of APCS will likely involve systems that are more rigid and less flexible to adapt to changing needs. ___

2. Autonomous and self-optimizing systems in APCS will require constant human intervention to adjust their operations. ___

3. Cloud computing and 5G networks will allow operators to monitor and control processes remotely, improving flexibility and responsiveness. ___

4. Model Predictive Control (MPC) is expected to be less useful in industries requiring precise control, such as chemicals and energy production. ___

5. AI-driven algorithms in APCS will continuously evolve and adjust the system to new conditions without manual reprogramming. ___

6. The future of APCS is solely focused on reducing human involvement in operations. ___

7. Future APCS will be designed to be modular, making them adaptable to changing production needs and easier to maintain. ___

8. Real-time data and edge computing will reduce network demands and improve decision-making for time-sensitive operations. ___

Task 4. Answer the questions according to the text.

1. What industries benefit from Automated Process Control Systems (APCS), and why are these systems important in these industries?

____

2. Explain how Feedback Control Systems work and provide an example of where this type of control system might be used.

____

3. What distinguishes Feedforward Control Systems from Feedback Control Systems? Can you give an example where a Feedforward Control System would be preferred?

____

4. Describe Cascade Control Systems. How do they improve process control, and what is a real-world example of their application?

____

5. What is Model Predictive Control (MPC), and in which industries is it commonly applied?

____

6. List the main components of an Automated Process Control System (APCS) and explain the role of each component.

____

7. What are the different types of sensors used in APCS, and what variables do they measure? Provide examples of how they work.

____

8. Describe the function of the controller in an APCS. How does a PID controller operate, and what are the three components that make it work?

____

9. What are actuators, and how do they interact with controllers in an Automated Process Control System? Provide an example.

____

10. Explain the purpose and function of the Human-Machine Interface (HMI) in an APCS. How does it benefit operators?

____

Task 5. ***Choose a topic from the following list and present your own project.***

1. Design a "Smart Factory" of the Future

Task: Imagine you are an engineer tasked with designing a "smart factory" for the future, fully equipped with Automated Process Control Systems. Create a concept for this factory, outlining the types of processes that will be controlled, the technologies integrated (e.g., IIoT, AI, MPC), and how the systems will interact with each other. Draw a diagram of how the factory might look, and describe how automation, AI, and human-machine collaboration will work in synergy.

2**. Design a New Type of Sensor for APCS**

Task: Imagine that you are tasked with designing the next-generation sensor for use in APCS. The sensor should be able to measure multiple parameters at once (such as temperature, pressure, and chemical composition) with greater accuracy and sensitivity. Sketch your sensor design, and write a brief description of its key features, including how it will improve process control and data acquisition in industrial settings.

3. Create a Virtual Reality (VR) Training Module for Operators

Task: Design a virtual reality training module for new operators learning how to interact with an advanced APCS. The module should teach operators how to monitor and manage systems that use AI, IIoT, and edge computing. Describe the key features of the VR experience, such as real-time system data visualization, troubleshooting simulations, and scenario-based learning exercises.

4. Develop a Product Concept for a Modular APCS System

Task: Imagine you are an entrepreneur tasked with developing a new APCS product that is modular and highly flexible. Create a concept for this product that can be customized to meet the specific needs of different industries. Describe how the product works, the types of industries it would be suitable for, and how it helps companies scale their operations up or down easily.

5. Design a Future APCS Cybersecurity System

Task: Create a conceptual design for an APCS cybersecurity system that uses AI to detect anomalies, prevent intrusions, and protect sensitive data. Describe how the system uses encryption, authentication, and real-time monitoring to secure data from IIoT devices. Imagine how this system would adapt to new types of cyber threats and integrate seamlessly with existing APCS infrastructure.

Task 6. ***Writing. Choose the topic the following list and present your own project.***

1. Create an Advertisement for an AI-Enhanced APCS System

Task: Imagine you are the marketing director of a company that sells advanced APCS systems integrating AI and edge computing. Write an advertisement or a promotional brochure for this system. Focus on its benefits like predictive maintenance, real-time decision-making, and how it helps industries improve efficiency, safety, and sustainability.

2. Write a Futuristic News Article

Task: Write a news article from the year 2035 about the latest breakthroughs in APCS. Imagine how AI, machine learning, edge computing, and cybersecurity have transformed industries, with case studies from various sectors such as manufacturing, pharmaceuticals, and energy. Discuss how these technologies have improved safety, cost savings, and environmental sustainability. Use your imagination to predict how these advancements have shaped the global economy and workforce.

UNIT 3

MICROPROCESSOR AND COMPUTER TECHNOLOGY

Task 1. Read and translate the following text.

Application of Microprocessor and Computer Technology in Manufacturing

Microprocessors and computer technology have revolutionized the manufacturing industry by enabling automation, enhancing precision, and improving efficiency. The integration of these technologies into various aspects of manufacturing has led to significant advancements in production capabilities, quality control, and overall system management. Below are some key areas where microprocessors and computer technology are applied in manufacturing.

Automation and Robotics

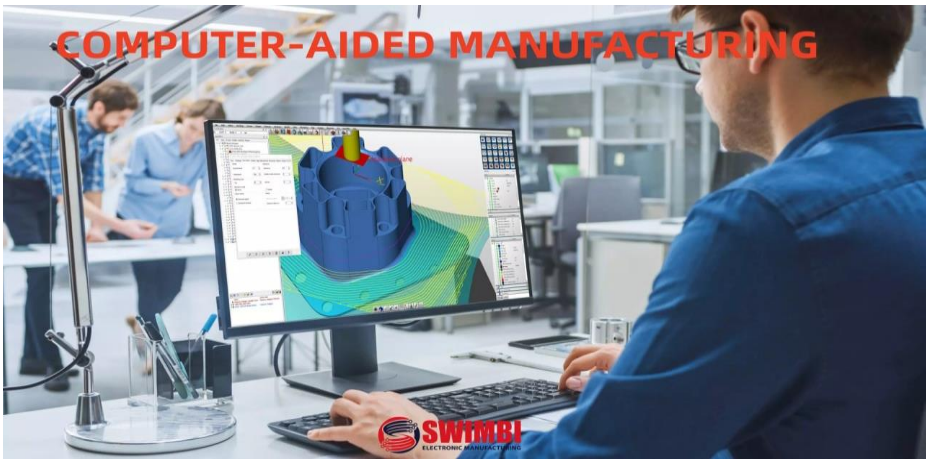
Modern manufacturing systems often rely on microprocessors to control automated machinery and robots. Microprocessors enable machines to perform tasks such as assembly, welding, painting, and packaging with high precision and repeatability. Robots, powered by microprocessors, are capable of performing complex and repetitive tasks, reducing human error and improving efficiency. These robots can be programmed to adapt to various tasks, handle materials, and work alongside humans in collaborative environments (cobots).

Computer Numerical Control (CNC) Machines

CNC machines are heavily reliant on microprocessors and computer technology to automate the control of machining tools like lathes, mills, and grinders. These machines execute precise movements based on pre-programmed computer codes (G-code), allowing manufacturers to produce complex parts with high accuracy. Microprocessors in CNC machines interpret the code to precisely control the movement of motors and actuators, ensuring that each part is manufactured according to design specifications. Process Control Systems

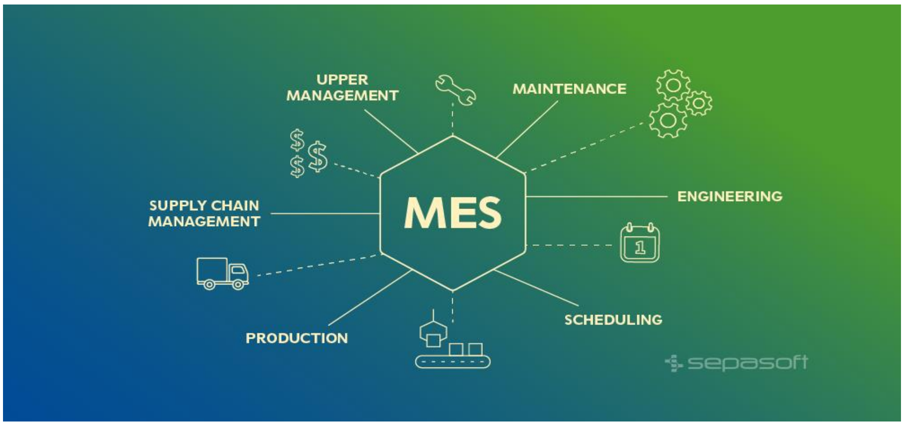
Microprocessors enable real-time monitoring and control of manufacturing processes, ensuring that the production process is operating within predefined parameters. These systems collect data from sensors (e.g., temperature, pressure, humidity) and adjust machine settings accordingly to maintain optimal conditions. In processes such as injection molding, metal forging, and chemical manufacturing, microprocessors adjust machine parameters (e.g., speed, temperature) to ensure consistency in product quality and minimize waste.

Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM)



Microprocessors are used to run sophisticated CAD software, allowing engineers and designers to create 2D and 3D models of parts and assemblies. CAD software helps in visualizing and testing designs before production, reducing the likelihood of design errors. After the design phase, CAM software, driven by microprocessors, generates the instructions (tool paths) needed for CNC machines, 3D printers, or other manufacturing equipment to produce the designed parts. This streamlines the transition from design to production. In the automotive industry, CAD and CAM software, powered by microprocessors, are used to design and manufacture intricate components, such as engine parts or body panels, with high precision and reduced lead times.

Manufacturing Execution Systems (MES)



Manufacturing Execution Systems are computer-based systems used to monitor and control production processes on the factory floor. They provide real-time tracking of materials, machinery, and personnel, ensuring that production runs smoothly and efficiently. MES systems, supported by microprocessors and computer technology, integrate with ERP systems to manage orders, inventory, and supply chains. This creates a seamless flow of information from the shop floor to the upper management levels, improving decision-making and resource allocation.

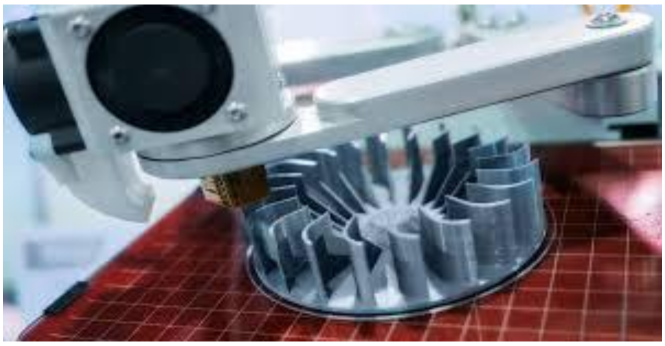
Quality Control and Inspection

Microprocessors and computer technology are used to implement computer vision systems for automated inspection and quality control. These systems use cameras and sensors to detect defects, measure dimensions, and verify the quality of parts during or after the manufacturing process. Microprocessors can analyze data from sensors or cameras to identify defects such as cracks, scratches, or dimensional inaccuracies. The system can then adjust manufacturing parameters to correct these issues in real time. In electronics manufacturing, automated optical inspection (AOI) systems powered by microprocessors are used to detect soldering defects on printed circuit boards (PCBs), ensuring product quality before shipment.

Supply Chain and Inventory Management

Microprocessors enable the development of advanced inventory management systems that track materials and finished products throughout the manufacturing process. These systems help optimize stock levels, reduce material waste, and avoid production delays. Radio Frequency Identification (RFID) tags, powered by microprocessors, are used to track the movement of raw materials, work-in-progress items, and finished products across the supply chain, improving efficiency and reducing the likelihood of errors.

Additive Manufacturing (3D Printing)



Microprocessors control additive manufacturing (3D printing) systems that build parts layer by layer from digital models. These systems use computer software to translate CAD designs into machine instructions, driving the printer to create complex shapes and structures with minimal waste. Microprocessors enable the rapid prototyping of custom parts and products, allowing manufacturers to test designs before committing to full-scale production. This is especially valuable in industries such as aerospace, automotive, and healthcare.

Predictive Maintenance

Microprocessors are used in predictive maintenance systems that monitor the health of machinery and equipment. These systems collect data from sensors embedded in machines (e.g., vibration, temperature, and pressure) and analyze it to predict potential failures before they occur. By analyzing historical data and current conditions, these systems can schedule maintenance activities only when necessary, reducing downtime and extending the lifespan of equipment.

Energy Management

Microprocessors enable energy management systems to monitor and optimize energy usage across manufacturing plants. These systems track energy consumption in real time and adjust production schedules or equipment settings to minimize energy waste. By integrating with other systems like HVAC and lighting, energy management systems can ensure that energy is used efficiently throughout the manufacturing process, helping to reduce costs and improve sustainability.

The application of microprocessor and computer technology in manufacturing has led to significant improvements in automation, efficiency, quality control, and supply chain management. These technologies enable manufacturers to produce high-quality products faster, with greater precision, and at lower costs. By integrating microprocessors into key manufacturing processes, companies can optimize operations, reduce human error, and stay competitive in the increasingly complex global market.

VOCABULARY

Automation – автоматизація

Robotics - робототехніка

Precision - Точність

Assembly Line - конвеєр

Collaborative Robots (Cobots) - роботи для співпраці (коботи)

Task Adaptation - адаптація до виконання завдань

Efficiency – ефективність

CNC Machines - Верстати з ЧПК

G-code - G-код

Tool Control - управління інструментом

Actuators - приводи

Motor Movements - рух двигуна

Data Collection - Збір даних

Injection Molding - лиття під тиском

Real-time Monitoring - моніторинг в режимі реального часу

CAD - Автоматизоване проектування

Tool Paths - траєкторії інструментів

Machine Instructions - інструкції для верстатів

Product Prototyping - прототипування продуктів

Defect Detection - Виявлення дефектів

Dimensional Accuracy - точність розмірів

Real-time Adjustment - регулювання в реальному часі

Supply Chain – Ланцюг поставок

Inventory Management – Управління товарними запасами

RFID – радіочастотна ідентифікація

Material Tracking- відстеження матеріалів

Waste Reduction – скорочення відходів

Production Delays - затримки виробництва

Task 2. ***Tick True or False***

1. Microprocessors in robotics enable machines to perform repetitive tasks with high precision and minimal human intervention. ___
2. CNC machines use microprocessors to control the cutting tools and execute movements based on pre-programmed codes like G-code. ___
3. Process control systems powered by microprocessors are not capable of adjusting machine parameters in real-time. ___
4. CAD software helps engineers visualize and design products, while CAM software translates designs into machine instructions for manufacturing. ___
5. Manufacturing Execution Systems (MES) track only raw materials, not machinery or production status. ___
6. Automated Optical Inspection (AOI) systems use microprocessors to detect defects in electronics manufacturing, such as soldering errors. ___

7. Additive manufacturing (3D printing) uses microprocessors to create parts layer by layer from digital designs, allowing for fast prototyping. ___

8. Predictive maintenance systems powered by microprocessors rely on real-time data analysis to predict potential machine failures before they occur. ___

9. Energy management systems using microprocessors are designed to increase energy consumption to maximize production speed. ___

Task 3. ***Fill-in-the-Gap Questions, using the words in the box***

G codes	computer vision	temperature	CAD
automation and robotics	RFID	the printer	
materials	predictive maintenance	energy	

1. Microprocessors are used in ____________ to control robotic movements and perform tasks like welding, assembly, and packaging.

2. CNC machines rely on microprocessors to interpret ____________, which instruct the machine on precise movements for cutting and shaping materials.

3. Manufacturing Execution Systems (MES) help track ____________, machinery, and personnel in real-time to improve factory operations.

4. In quality control, microprocessors in ____________ systems can detect defects like cracks or scratches on parts during or after production.

5. In additive manufacturing (3D printing), ____________ is responsible for creating parts layer by layer based on digital designs and microprocessor instructions.

6. ____________ systems are used to predict when equipment will fail by analyzing data from sensors monitoring vibrations, temperature, and pressure.

7. Microprocessors optimize ____________ management by monitoring energy usage and adjusting machine settings to reduce energy waste.

8. Microprocessors allow ____________ software to create virtual prototypes of products, which can then be tested and modified before production.

9. Using ___________ tags, powered by microprocessors, companies can track the movement of materials and products across the supply chain.

10. In process control systems, microprocessors adjust machine parameters like speed and ___________ to maintain optimal production conditions.

Task 4. ***Read and translate the following text.***

Examples of how microprocessor and computer technology are directly applied in manufacturing:

A Computer Numerical Control (CNC) milling machine used in the automotive industry to create engine parts. The machine is controlled by a computer, which reads the design specifications and precisely controls the cutting tools to carve out the part from a metal block. Benefit: This technology allows the production of highly complex and accurate parts, such as engine blocks or turbine blades, with minimal human intervention.

In an electronics manufacturing plant, robots equipped with vision systems use microprocessors to assemble circuit boards. Robots can insert components like resistors and capacitors into PCBs (printed circuit boards), then place them in a soldering station, all while performing quality checks. Benefit: Increases speed, reduces human error, and improves safety in repetitive tasks.

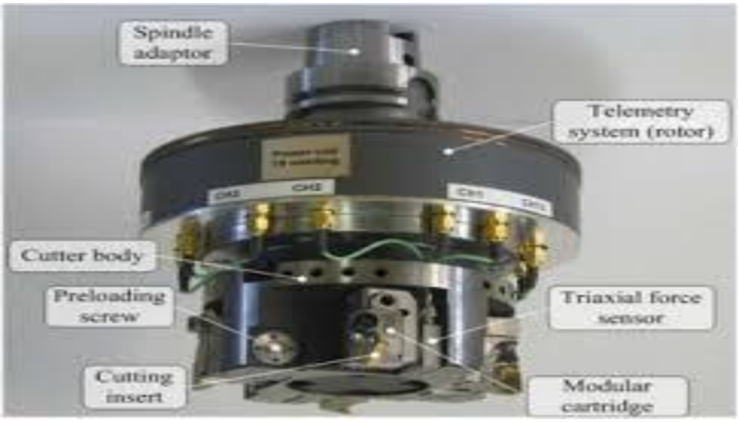
Automated Guided Vehicles (AGVs) powered by microprocessors are used in warehouse and distribution centers (e.g., Amazon or Tesla). These vehicles automatically transport parts from storage areas to assembly lines without human operators. Benefit: Enhances efficiency in material handling, reduces manual labor, and improves safety by avoiding human errors in logistics.

BMW employs a flexible manufacturing system where microprocessor-controlled machines and robots can quickly change from producing one model of car to another without retooling. The system adjusts automatically based on the incoming order. Benefit: Maximizes productivity by allowing manufacturers to switch between different models of cars on the same production line without extensive downtime.

A 3D printer is used to create customized orthopedic implants. The printer, controlled by a computer, deposits material layer by layer to create a precise replica of a patient's bone structure. Benefit: Enables the production of highly personalized medical devices and prototypes with intricate details, reducing the need for costly molds and tooling.

In a chemical processing plant, microprocessors monitor variables like temperature, pressure, and chemical composition during the production of fertilizers or petrochemicals. A Distributed Control System (DCS) automatically adjusts the production parameters to maintain optimal quality. Benefit: Reduces human errors, ensures product consistency, and minimizes waste by maintaining precise control over manufacturing conditions.

Cognex vision systems use cameras and software powered by microprocessors to inspect parts during production. For example, in the pharmaceutical industry, these systems ensure that every bottle of medicine is filled to the correct level and sealed properly. Benefit: Increases inspection speed, reduces errors, and eliminates the need for manual quality checks, improving product reliability.



In a steel mill, sensors installed on machinery collect real-time data on vibration, temperature, and pressure. Microprocessors analyze this data to predict when equipment (e.g., furnaces or rolling mills) might fail. Benefit: Prevents unexpected breakdowns by scheduling maintenance in advance, minimizing downtime and reducing repair costs.

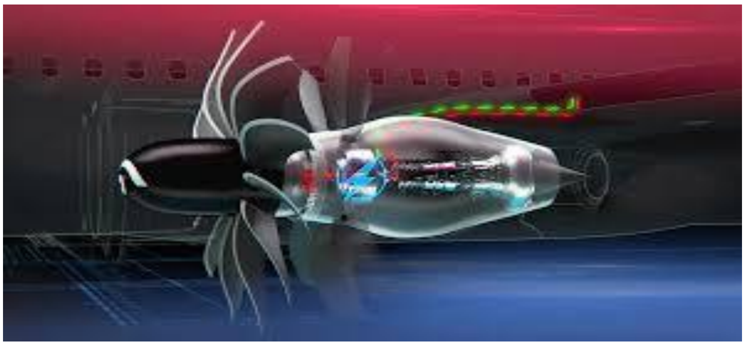
In a retail distribution center, RFID tags on products are scanned by readers equipped with microprocessors. The system automatically tracks the location of every item in the warehouse and can send an alert when stock is low. Benefit: Reduces inventory errors, speeds up order fulfillment, and ensures that shelves are always stocked with the right products.

In a factory, a smart energy management system powered by microprocessors monitors energy usage across different machines and adjusts their power settings in real-time to optimize consumption. This system can turn off machines during non-production hours or reduce power usage during peak times. Benefit: Helps reduce energy costs, optimize resource use, and contribute to sustainable manufacturing practices.

In a car manufacturing plant, robotic arms equipped with sensors and microprocessors are used for spot welding on car body panels. The robots position the metal parts, adjust the welding parameters, and perform the welds autonomously. Benefit: Ensures uniform and precise welds, speeds up production, and improves safety by removing human workers from hazardous environments.

In a food processing plant, microprocessors are used to control and monitor the temperature and mixing speed during the production of products like yogurt or sauces. The system adjusts these variables based on feedback from sensors to maintain product consistency. Benefit: Reduces the chance of human error, improves consistency, and minimizes the need for manual oversight.

In a pharmaceutical packaging line, a microprocessor-controlled smart packaging machine automatically adjusts packaging size and sealing methods based on the product type. It can also verify the expiration date and batch number using optical sensors. Benefit: Increases production efficiency, reduces packaging errors, and ensures compliance with regulations.



General Electric (GE) uses virtual prototyping to design complex jet engines. By creating digital models of the engines and simulating performance in various environments, GE can fine-tune designs and test them without having to build physical prototypes. Benefit: Saves time and cost in the product development cycle and improves product performance before manufacturing starts.

These examples show how microprocessors and computer technology are integral to the modern manufacturing process, automating tasks, improving precision, ensuring quality control, optimizing resources, and enhancing safety. The widespread application of these technologies leads to smarter, faster, and more efficient production systems across diverse industries.

VOCABULARY

Computer Numerical Control (CNC) - Комп'ютерне числове програмне керування (ЧПК)

engine parts - деталі двигуна

cutting tools - ріжучі інструменти

human intervention - втручання людини

turbine blades - турбінні лопаті

circuit boards - монтажні плати

capacitors - конденсатори

soldering - пайка

quality checks - перевірка якості

human error - людські помилки

repetitive tasks - одноманітні завдання

Automated Guided Vehicles (AGVs) - Автоматизовані керовані транспортні засоби (AGV)

Warehouse - Склад

material handling - обробка матеріалів

manual labor - ручна праця

retooling - переоснащення

downtime - простої

Distributed Control System (DCS) - Розподілена система управління (DCS)

product consistency - стабільність продукту

energy usage - використання енергії

power settings - налаштування живлення

sustainability - стійкість

packaging size - розмір упаковки

sealing methods - методи запечатування

expiration date - термін придатності

batch number - номер партії

compliance - відповідність

Task 5. ***Fill-in-the-Blank, using words from the Vocabulary.***

1. __________ (CNC) machines are used in the __________ industry to create precise __________ using automated __________ for cutting materials without requiring much __________.
2. In electronics manufacturing, robots assemble __________ by inserting components like __________ and placing them in a __________ station for final processing.
3. Automated systems in warehouses, such as __________ (AGVs), are used for __________ tasks, reducing __________ and improving safety and efficiency.
4. A __________ (DCS) helps maintain __________ in the production process by continuously monitoring variables and adjusting parameters, resulting in __________.
5. __________ is essential in production plants to reduce __________ and improve __________ by optimizing __________ and adjusting __________ to minimize consumption.
6. In pharmaceutical packaging, a smart machine automatically adjusts the __________ and __________ based on the product type, ensuring accurate labeling, including __________ and __________ for regulatory __________.

Task 6. ***Tick True or False***

1. Computer Numerical Control (CNC) machines are used to create engine parts in the automotive industry by manually controlling cutting tools. ___
2. Automated Guided Vehicles (AGVs) are used in warehouses for material handling, reducing the need for manual labor and preventing downtime in the supply chain.____
3. Distributed Control Systems (DCS) are used in industries to ensure product consistency by monitoring energy usage and adjusting power settings in real-time. ___
4. Soldering and quality checks are tasks that robots in electronics manufacturing perform to minimize human error during repetitive tasks. ___
5. Energy usage can be optimized for sustainability in manufacturing by adjusting packaging size and sealing methods to reduce waste. ___

Task 7. ***Fill-in-the-Blank with Word Bank***

energy usage	soldering	turbine blades
energy usage	material handling	packaging size
CNC	repetitive tasks	sustainability
quality checks	compliance	batch number

1. In electronic manufacturing, robots use __________ to insert components and perform __________ to ensure that every circuit board is assembled correctly.
2. __________ are produced in automotive plants using CNC machines to carve out parts from a metal block, ensuring precision and reducing human intervention.
3. In a warehouse, Automated Guided Vehicles (AGVs) handle __________ and reduce the need for manual labor, improving logistics efficiency.
4. During the packaging process, the __________ and sealing methods are monitored by microprocessors to ensure __________ with regulatory standards.

5. A Distributed Control System (DCS) is used in manufacturing to monitor ___________ and adjust power settings, optimizing resources for sustainability.

TESTING EXERSISES

Unit 1.

Task 1. ***Choose the correct answer for each question.***

1. What does MPC (Model Predictive Control) do?

a) Adjusts system parameters based on input changes

b) Uses a mathematical model to predict and optimize future outputs

c) Relies on human intervention for process control

d) Distributes control tasks across various systems

2. Which of the following is a primary benefit of APCS?

a) Increased system complexity

b) Improved process efficiency and quality

c) Increased manual labor requirements

d) Higher system cost

3. Which of the following is a primary function of the Human-Machine Interface (HMI)?

a) To control the physical process directly

b) To collect data for analysis

c) To allow operators to monitor and control the process

d) To adjust control parameters in real-time

4. Which control strategy involves adjusting parameters based on human-like decision-making using linguistic variables?

a) PID Control

b) Adaptive Control

c) Fuzzy Logic Control

d) Cascade Control

Task 2. ***Decide if the statement is true or false.***

1. A PLC (Programmable Logic Controller) is used for discrete on/off control tasks and operates based on ladder logic.
2. Adaptive control systems adjust their control parameters based on the changing behavior of the system.
3. Cybersecurity is not a concern for APCS because they are isolated from the internet.
4. Distributed Control Systems (DCS) involve a central unit managing the entire process.

Task 3. ***Answer the following questions.***

1. What is the primary function of a PID controller in an APCS?

a) To store process data

b) To adjust the process based on historical errors

c) To calculate error and apply corrective actions based on proportional, integral, and derivative terms

d) To manually override control settings

2. Which type of control system is best suited for situations where the impact of disturbances can be predicted before they affect the system?

a) Feedback Control System

b) Cascade Control System

c) Feedforward Control System

d) Distributed Control System (DCS)

3. Which of the following is a primary component in an APCS that gathers real-time data on process variables like temperature and pressure?

a) Controller

b) Sensor

c) Actuator

d) HMI (Human-Machine Interface)

4. Which of the following control strategies would be most appropriate for a system that needs to continuously adjust parameters in real-time due to changing process characteristics?

a) Model Predictive Control (MPC)

b) Adaptive Control

c) PID Control

d) Fuzzy Logic Control

5. What is the key difference between Distributed Control Systems (DCS) and Programmable Logic Controllers (PLC)?

a) DCS is used for discrete control, while PLC is used for continuous control

b) DCS uses a single controller for the entire process, while PLC uses multiple controllers

c) DCS is used for complex processes with multiple subsystems, while PLC is typically used for discrete or sequential processes

d) DCS is designed for controlling only electrical systems, while PLC is for controlling physical systems

6. Which of the following benefits of APCS can help reduce operational costs?

a) Increased need for manual interventions

b) Improved system complexity

c) Reduced downtime and increased throughput

d) Increased reliance on human operators for adjustments

7. In an Automated Process Control System (APCS), which component is responsible for physically altering the process based on control signals?

a) Sensor

b) Controller

c) Actuator

d) HMI

8. Which control system uses linguistic variables such as "high," "medium," and "low" to make decisions and adjust process parameters?

a) PID Control

b) Fuzzy Logic Control

c) Adaptive Control

d) Model Predictive Control (MPC)

9. What is the primary function of a Human-Machine Interface (HMI) in an APCS?

a) To collect data from sensors

b) To display real-time data, trends, and alerts to operators

c) To control the physical process directly

d) To execute the control strategies

10. Which control system would be best suited for a highly complex, large-scale system where different subsystems must be controlled independently but in coordination?

a) Model Predictive Control (MPC)

b) Distributed Control System (DCS)

c) Feedforward Control System

d) PID Control System

11. Which of the following is a major challenge faced by industries when implementing APCS?

a) Easy and low-cost implementation

b) Decreased energy consumption

c) System complexity and integration with existing infrastructure

d) Lack of data for optimization

12. What role does Model Predictive Control (MPC) play in industrial processes like oil refining?

a) It provides on/off control for basic operations

b) It optimizes control actions based on a mathematical model, accounting for time delays and constraints

c) It monitors real-time temperature changes only

d) It manually adjusts variables based on human input

13. Which of the following is a key factor in ensuring the success of an Automated Process Control System in terms of safety?

a) Constant operator supervision

b) Continuous monitoring of processes and intervention when necessary

c) Frequent system shutdowns for maintenance

d) Use of outdated sensors for data collection

14. Which of the following is a primary concern regarding APCS as they become more connected with technologies like Industry 4.0 and IIoT?

a) Data privacy and cybersecurity risks

b) Increased demand for manual labor

c) Limited data collection

d) Complexity in system configuration

15. Which of the following control strategies is typically used in systems where processes involve continuous and dynamic changes that need to be predicted and adjusted proactively?

a) Feedforward Control

b) Adaptive Control

c) Model Predictive Control (MPC)

d) Distributed Control System (DCS)

Task 4. ***Answer the questions according to the text***

1. What are the main control strategies used in APCS? Explain the role of PID control and how it can be tuned for optimal performance.
2. How does adaptive control work, and in what scenarios is it beneficial? Give an example of its application.
3. What is fuzzy logic control, and how does it differ from traditional control methods? Provide an example of its use in an automated system.
4. Describe a Distributed Control System (DCS) and provide an example of where it might be used in a large-scale operation.
5. How do Programmable Logic Controllers (PLCs) work, and in which industries are they most commonly applied?
6. List the key benefits of implementing an Automated Process Control System. How do APCS improve efficiency, safety, and quality?
7. What are the main challenges of implementing APCS, and how can these challenges be addressed?
8. What is the role of cybersecurity in the implementation of APCS, especially with the rise of Industry 4.0 and IIoT?
9. How does APCS contribute to data collection and analysis, and what role does this play in process optimization?
10. Explain the relationship between APCS and cost savings in industrial operations. How do automated systems reduce operational costs?

Unit 2

Task 1. ***Answer the questions.***

1. What is the role of AI and ML in the future of APCS?

a) Decrease energy usage

b) Improve system performance by analyzing data for predictive maintenance

c) Decrease system security risks

d) Control hardware manually

2. What is the main benefit of Edge Computing in APCS?

a) Centralized data processing

b) Reduced latency and faster response times for real-time control

c) Increased data storage requirements

d) Automatic shutdown of systems

3. What technology will enable APCS to achieve "smart factories"?

a) Artificial Intelligence (AI)

b) Industrial Internet of Things (IIoT)

c) Augmented Reality (AR)

d) Edge Computing

4. How will sustainability goals be achieved in the future of APCS?

a) By optimizing processes and reducing waste

b) By increasing energy consumption

c) By reducing the need for human labor

d) By maintaining outdated control systems 1. Industry 4.0 focuses on integrating automated systems with IIoT to enable real-time monitoring and decision-making.

Task 2. ***Tick True or False***

1. Industry 4.0 focuses on integrating automated systems with IIoT to enable real-time monitoring and decision-making. ___
2. The integration of AI and ML in APCS helps with predictive maintenance, anomaly detection, and process optimization. ___
3. Edge computing processes data in central data centers, resulting in higher latency and slower decision-making. ___
4. Cybersecurity in APCS involves advanced encryption, authentication, and intrusion detection systems to prevent cyber threats. ___
5. Augmented Reality (AR) can be integrated with APCS to provide immersive control and visualization tools for operators. ___
6. Sustainability is not a key factor in the future development of APCS systems.
7. Advanced sensors in APCS will enable higher-resolution data acquisition and precise process control. ___
8. The future of APCS will likely involve systems that are more rigid and less flexible to adapt to changing needs. ___
9. Autonomous and self-optimizing systems in APCS will require constant human intervention to adjust their operations. ___
10. Cloud computing and 5G networks will allow operators to monitor and control processes remotely, improving flexibility and responsiveness. ___
11. Model Predictive Control (MPC) is expected to be less useful in industries requiring precise control, such as chemicals and energy production. ___
12. AI-driven algorithms in APCS will continuously evolve and adjust the system to new conditions without manual reprogramming. ___
13. The future of APCS is solely focused on reducing human involvement in operations. ___
14. Future APCS will be designed to be modular, making them adaptable to changing production needs and easier to maintain. ___

15. Real-time data and edge computing will reduce network demands and improve decision-making for time-sensitive operations. ___

Task 3. ***Answer the following questions according to the text.***

1. What benefits do modular and scalable systems offer to the design and maintenance of APCS?
2. Why is real-time data processing critical for time-sensitive operations in APCS?
3. How will cloud computing and 5G networks transform the management of APCS?
4. What challenges might arise with the increasing complexity of APCS in the future?
5. Explain the concept of "smart factories" in the context of APCS.

Task 4. Complete the test.

1. Which of the following technologies is central to the future of Automated Process Control Systems (APCS)?

a) Artificial Intelligence (AI)

b) Quantum Computing

c) Blockchain

d) 3D Printing

2. What is one primary advantage of integrating APCS with Industry 4.0 and the Industrial Internet of Things (IIoT)?

a) It reduces energy consumption by 50%

b) It allows systems to autonomously adjust and optimize processes

c) It eliminates the need for human workers

d) It limits communication between machines

3. Which control strategy is expected to see increased use in APCS due to its ability to manage processes with multiple variables and time delays?

a) Proportional-Integral-Derivative (PID) Control

b) Feedback Control

c) Model Predictive Control (MPC)

d) Adaptive Control

4. What role will Artificial Intelligence (AI) and Machine Learning (ML) play in the future of APCS?

a) AI and ML will be used for predictive maintenance, anomaly detection, and process optimization

b) AI will replace human operators entirely

c) ML will control the physical processes without human oversight

d) AI will only be used for visual enhancements on Human-Machine Interfaces (HMIs)

5. Which of the following is a benefit of integrating Augmented Reality (AR) and Virtual Reality (VR) with APCS?

a) It reduces the need for sensors

b) It provides immersive, intuitive control and visualization for operators

c) It eliminates the use of physical controllers

d) It only serves as an entertainment tool for employees

Unit 3

Task 1 ***Answer the questions according to the text***

1. What role do microprocessors play in automation and robotics?

a) Only for controlling assembly lines

b) Control robotic movements with precision

c) Manage inventory in the warehouse

d) Store data for later use

2. Which of the following is true about CNC machines?

a) They do not use microprocessors for tool control.

b) Microprocessors interpret G-code to control machining tools.

c) CNC machines only work with simple shapes and designs.

d) They replace human workers completely in every task.

3. Which process is controlled in real-time by microprocessors in manufacturing?

a) Only design testing

b) Only inventory tracking

c) Temperature, pressure, and speed adjustments in manufacturing

d) Only packaging and labeling

4. What does CAM software do in manufacturing?

a) Generates 3D models of products

b) Translates CAD designs into machine instructions

c) Controls robotic arms directly

d) Tracks inventory and supply chains

5. Which technology is used in Manufacturing Execution Systems (MES) to ensure smooth production flow?

a) AI for design improvement

b) Real-time tracking of materials, machinery, and personnel

c) Printing parts directly on-site

d) Direct manual control of machines

6. In quality control, what is the primary function of microprocessor-controlled computer vision systems?

a) Enhance product design

b) Detect defects and verify part quality

c) Optimize energy consumption

d) Track inventory levels

7. What is the key advantage of using microprocessors in additive manufacturing (3D printing)?

a) Reducing energy consumption only

b) Creating parts layer by layer based on digital designs

c) Automating entire production lines

d) Enhancing human worker skills

8. How does predictive maintenance benefit manufacturing?

a) By preventing any machinery downtime

b) By reducing the need for human intervention

c) By predicting failures and scheduling maintenance activities in advance

d) By increasing overall energy consumption

Task 2. ***Choose the topic and prepare the report.***

1. Automation and Robotics

Understand how microprocessors enhance automation and robotics in manufacturing.

A. Describe how microprocessors control robotic arms in an assembly line.

B. Identify at least three tasks that robots powered by microprocessors can perform.

C. Compare traditional manufacturing methods with robotic automation. What are the key benefits of robotic automation in terms of precision and cost?

2. Computer Numerical Control (CNC) Machines

Learn about the role of microprocessors in CNC machines for precision manufacturing.

A. What is the function of a microprocessor in CNC machines?

B. Explain how CNC machines improve the accuracy of manufactured parts.

C. Define G-code and its role in CNC machining.

D. Discuss how microprocessors allow for customization and quick changes in CNC operations.

3. Process Control Systems

Understand the impact of microprocessors on process control systems in manufacturing.

A. What types of data do process control systems typically collect from sensors?

B. How do microprocessors maintain optimal production conditions in manufacturing processes?

C. Describe an example of a manufacturing process (e.g., injection molding) and explain how microprocessors control temperature and pressure.

4. Manufacturing Execution Systems (MES)

Objective: Learn about the role of microprocessors in monitoring and controlling production processes.

A. Define Manufacturing Execution Systems (MES) and their purpose in manufacturing.

B. Explain how microprocessors enable real-time tracking of materials, machinery, and personnel.

C. How do MES and ERP systems integrate, and why is this integration important?

Text 2.

Task 1. ***Answer the questions.***

1. What is the role of Computer Numerical Control (CNC) machines in the automotive industry?

a) To reduce human error in cutting processes

b) To create engine parts with high precision and minimal human intervention

c) To monitor energy usage during production

d) To assemble turbine blades using manual labor

2. What task do Automated Guided Vehicles (AGVs) perform in a warehouse?

a) Control the quality of circuit boards

b) Transport materials to assembly lines

c) Perform repetitive tasks in electronics assembly

d) Assemble engine parts

3. Which of the following is controlled by a Distributed Control System (DCS)?

a) Packaging size and sealing methods

b) Energy usage and power settings for product consistency

c) Turbine blades in an automotive factory

d) Quality checks in the pharmaceutical industry

4. What is one of the benefits of using microprocessors for repetitive tasks in manufacturing?

a) Decreasing the need for robotic arms

b) Reducing manual labor and human error

c) Decreasing the speed of production

d) Increasing downtime

5. In packaging, microprocessors help by adjusting __________ to ensure that the product is sealed properly and meets __________ standards.

a) Energy usage; waste reduction

b) Sealing methods; compliance

c) Repetitive tasks; quality checks

d) Cutting tools; engine parts

Task 2. ***Match the term on the left with the correct description on the right.***

Term	***Description***
1. Automated Guided Vehicles (AGVs)	A) Reduces errors and ensures precision in the assembly of products like circuit boards
2. Soldering	B) Used to move materials automatically in warehouses, improving logistics and reducing manual labor
3. Distributed Control System (DCS)	C) A system used to monitor and control temperature, pressure, and other variables to ensure product consistency
4. CNC Milling Machine	D) Process that joins components together using heat, widely used in electronics and automotive manufacturing
5. Packaging Size	E) A machine used to control cutting tools for creating engine parts and turbine blades with minimal human intervention

COMMUNICATION SKILLS 1

AUTOMATED PROCESS CONTROL SYSTEMS

Task 1. ***Listening to the extract*** (***see the transcription on the page 67) and answer the following questions.***

1. Explain how sensors are used in an automated process.
2. What are the benefits of using automation in manufacturing processes?
3. Describe the steps involved in a simple automated system, such as an automated car wash.
4. How does the PLC contribute to automation in industrial settings?
5. What are some examples of output devices in an automated system?

Task 2. ***Tick True or False.***

1. Automation is only used in industrial manufacturing processes.
2. The input devices in automation processes always require human intervention to work properly.
3. Once the PLC receives an input, it sends a command to activate output devices like motors and lights.
4. An automated process continues running until it receives a stop signal, which can be physical or programmed.
5. Human error is more likely to occur in an automated system compared to a manual process.

Task 3. ***Choose the correct answer.***

1. What is the main function of automation?

    a) To replace human workers entirely

    b) To reduce the need for machines in production

    c) To use automatic equipment to control manufacturing processes

    d) To only save time in manufacturing

2. Which of the following is NOT typically part of an automated process?
   a) Sensors
   b) Human intervention
   c) Robots
   d) Motors

3. What is the role of the PLC (Programmable Logic Controller) in an automated system?
   a) To input data from the sensors
   b) To activate output devices based on the programmed decisions
   c) To perform manual checks on machinery
   d) To design the automated process

4. What does "sequential starting" refer to in automation?
   a) Activating all output devices simultaneously
   b) The process of starting output devices in a specific order
   c) Turning off output devices when not needed
   d) The automatic turning off of machinery after one task is completed

5. How does a sensor in an automated car wash help the process?
   a) It sprays water onto the car
   b) It detects when the car reaches a certain point to trigger the next step
   c) It communicates directly with the driver
   d) It performs the cleaning tasks itself

Task 4. *Discussion/Group Activity*

In a group, discuss the following scenario:

You are tasked with automating a coffee-making process in a café.

How would you use automation to streamline the process from receiving an order to delivering the coffee to the customer?

Consider the use of sensors, PLCs, motors, and any other automation devices.

COMMUNICATION SKILLS 2
INDUSTRY 4.0 FOR PROCESS AUTOMATION

Task 1. ***Listen to the extract (see the transcription on the page 69) and answer the following questions.***

1. What is the primary purpose of the Internet of Things (IoT) in the process industry?

a) To store vast amounts of data for future use

b) To allow cyber-physical systems to communicate autonomously and generate data

c) To reduce energy consumption through manual controls

d) To replace human workers in the production process

2. Which of the following best describes Big Data in the context of Industry 4.0?

a) The collection of data that is impossible to process

b) The ability to access and process large amounts of data automatically

c) A tool used for physical product inspection

d) A type of manual data entry system for factories

3. What is a key feature of Industry 4.0 in production plants?

a) Increased human intervention in every step of the process

b) Autonomous decision-making based on data analysis

c) Limited integration of mechanical and electronic systems

d) Use of traditional, non-digital equipment for manufacturing

4. What does the "PID auto tuning function" do in an automated system?

a) Adjusts the speed of production equipment

b) Calculates the P and D percentage of controlled systems automatically

c) Manages human resources in the production process

d) Tracks raw material costs during production

5. What is the purpose of the Plant-acquisit system solution?

a) To manage data manually in production

b) To acquire and process intelligent operating data for reducing energy consumption

c) To oversee human workers during manufacturing

d) To standardize all production specifications

Task 2. ***Tick True or False***

1. The Internet of Things (IoT) enables physical devices to communicate autonomously with each other, generating data.
2. Big Data only involves collecting data without the ability to process or analyze it.
3. Self-optimizing systems in Industry 4.0 lead to more flexible and efficient production processes.
4. The Plant-liquid system is designed to optimize production by determining the next cleaning or transfer task.
5. Industry 4.0 is still a future vision and is not yet integrated into process control systems.

Task 3. ***Fill in the Blanks***

1. Industry 4.0 integrates technologies such as the Internet of Things (IoT) and ________ to improve production systems.
2. The automation system's ability to make autonomous decisions based on data is a key characteristic of ________.
3. ________ is a system solution that helps reduce energy consumption by dynamically activating and deactivating production units.
4. The ________ system helps in routing management by deciding which transfer or cleaning task needs to be executed.

5. The ________ solution supports customized production based on batch-based bills of materials and allows for small order volumes without storage costs.

Task 4. ***Create a concept map that connects the following terms and concepts.***

Industry 4.0	Internet of Things (IoT)
Big Data	Autonomous Decision-Making
Smart Factory	Process Automation 4.0
MES Solutions	Self-Optimizing Systems
PID Auto Tuning	Energy Efficiency

COMMUNICATION SKILLS 3

ELEMENTARY ROBOTICS - AI VISUAL INSPECTION SYSTEMS THAT LEVERAGE THE CLOUD AND MACHINE LEARNING

Task 1. ***Listen to the extract (see the transcription on the page 71) and match the terms in Column A with their correct description in Column B.***

Column A

AI and Deep Learning Prism Software Anomaly Detection

Cloud-Based Systems Root Cause Analysis

Machine Learning Algorithms Intelligent Quality Assurance

Column B

A. A technique used in manufacturing to identify trends and prevent future defects by analyzing historical data.

B. A system that automatically detects and flags deviations from expected patterns in production.

C. A technology that improves the accuracy and efficiency of production processes through self-learning from data.

D. A software solution that allows users to train machine learning models without needing developer-level coding skills.

E. A system that ensures production quality by detecting imperfections beyond the human eye and correcting them in real time.

F. A process that uses large amounts of data to improve system decision-making and identify patterns automatically.

G. A remote system that allows real-time data processing, analysis, and control from any location.

Task 2. ***Fill in the blanks with the correct answers from the options provided*.**

1. The use of ________ in vision inspection systems helps identify defects that may not be visible to the human eye.

a) AI

b) Cloud Computing

c) Deep Learning

d) Robotics

2. Prism software makes it possible to ________ and deploy machine learning algorithms without the need for a programming background.

a) Monitor

b) Train

c) Automate

d) Refine

3. By using ________, manufacturers can gain insights into product defects and reduce scrap rates.

a) Root Cause Analysis

b) AI-driven Anomaly Detection

c) Manual Inspections

d) Robotics

4. ________ is the technology that allows vision inspection systems to be deployed and accessed globally in real time.

a) Edge Computing

b) Cloud-Based Systems

c) AI

d) Robotics

Task 3. ***Read the following extract.***

A manufacturer in the automotive industry has adopted elementary robotics' vision inspection system, which uses AI to inspect parts for defects during production. Initially, the company had quality issues that led to significant returns and costly reworks. After integrating the system, they noticed fewer defects, quicker problem detection, and a reduction in scrap. However, production is still lagging behind demand due to issues with scaling and adjusting production lines quickly.

Answer the following questions.

1. How can AI and machine learning help the company improve the scalability of its production lines?
2. In what ways could real-time cloud-based deployment benefit the company in addressing production line issues?
3. What role does anomaly detection play in the company's efforts to reduce defects and improve overall productivity?
4. How can root cause analysis be applied to ensure that any recurring quality issues are fixed permanently?

TRANSCRIPTION 1

We hear about new things and processes becoming automated almost every day. But what does that actually mean? What exactly does automation mean?

Automation is the use of largely automatic equipment in a system of manufacturing or other production process. This typically includes the use of PLCs, sensors, robots, and motors among many other things depending on the automated process. Almost any process can become automated. It can save time and money to automate an industrial process. It also helps eliminate human error. Another upside is that the use of automation creates many high-paying careers for maintenance workers, engineers, and programmers. A simple everyday example of automation would be an ordinary pull-in and park automatic car wash. If we break it down step by step, it should help you understand how automation works.

Once you select your wash, that input will run a certain program on the controller. Next, you drive forward until a sensor is flagged, starting the wash cycle, and another sensor tells the driver when to stop. From there, the wash will continue through the cycle that the controller is running. In a typical car wash, the nozzle spraying the water and chemicals will travel alongside a vehicle, and a sensor will detect when it is past the vehicle. This saves time, water, and chemicals by controlling when the nozzle spray, as well as serves as an input to advance to the next step of the wash. Once the car is sprayed, the program tells the wash to spray the next chemical. This is done by the controller turning on and off each pump as it's needed. The controller then runs through the rest of the cycle and wash that was selected in the beginning. Once all steps have been completed, the driver will be signaled to pull out of the wash. Essentially, the only human intervention in the process is the driver selecting what wash they want. Industrial automation works exactly the same way. Each industrial process needs to be started by some sort of input. That input can be a sensor, push button, switch, among many other possibilities. Typically, a person will start the process with one of these input devices, or it could be a sensor that detects an object automatically. Those inputs will go to a PLC, which will then make decisions based on how it was programmed. The PLC will then activate whatever output the program says to run. An output can be anything that does work, such as a motor, solenoid, heater, or a light. In an automated process, that output will typically be programmed as an input to the PLC, and combined with other input devices or programming to keep the process running. With this programming, it can act like a chain reaction with one output device starting before the next is allowed to run. This is also called sequential starting. Automation has to have many aspects working together in order to function properly. An automated process will continue its cycle until it receives a stop signal. That can come from a physical input, such as a stop button or sensor, or something programmed like a timer. Let's look back at what we now know. Automation is an automatic process, typically controlled by computers and sensors. There is usually very little human intervention. Input devices, such as sensors and switches, will work with a controller or PLC to activate output devices like motors or other machinery. The PLC will advance as it was programmed.

Industrial robots are great examples of process automation, as they are commonly being used to replace humans in pallet loading operations.

TRANSCRIPTION 2

Industry 4.0 Internet of Things and Big Data are frequently used catch phrases. However, it is often not obvious what these terms actually mean and the potential benefit they can bring to the process industry. The Internet of Things is a scenario in which cyber-physical systems communicate with each other autonomously, thus generating an increasing amount of data.

Big Data refers to the ability to access vast amounts of data and to process it automatically. This results in valuable information leading to autonomous decision processes. Industry 4.0 utilizes these technologies and integrates them into production plant processes, thereby creating the smart factory, which seamlessly interconnects software, mechanics, electronics, and humans. But catch phrases alone fail to achieve real value added. For this reason, Industry 4.0 is already an integral part of our process control systems and MES solutions. We refer to it as process automation 4.0. Self-optimizing and flexible systems, such as the automation classes in plant direct IT, improve autonomous dosing processes, and the PID auto tuning function calculates the P and D percentage of controlled systems automatically, efficiently, and effectively. Plant-acquisit is our system solution for intelligent operating data acquisition. The collated data can be used to reduce energy consumption by dynamically activating and deactivating production units. Ever-changing production specifications demand flexible control systems that can adapt automatically. Plant-liquid, for example, offers the routing management add-on specifically for this purpose. Thanks to its fully configurable business rules and the integrated contamination matrix, our process control system is able to decide for itself which transfer or cleaning task needs to be executed next and always finds the perfect route through the production plant. Plant-batch IT supports customized production using batched-based bills of materials. This enables the direct realization of even the smallest order volumes based on customer wishes without storage costs or loss of production. The right decision should only be made once all the available information can be incorporated in a single evaluation. Our MES solution plant integrate IT links data from various systems, prepares it according to individual requirements, and displays the production plant's optimization potential immediately and in real-time. ProLite allows you to actively engage in industry 4.0, profit from network systems which communicate actively with each other and are able to make autonomous decisions based on predetermined rules. Self-optimizing production means you can deliver high-quality products more effectively and efficiently.

As usual, the best part comes last. At ProLite, industry 4.0 is no longer a vision but already reality. We have the right solutions to meet your requirements and to help you further develop your business model. Plant IT and Brumax provide you with process control technology. Industry 4.0 included.

TRANSCRIPTION 3

The world of manufacturing is evolving, cycling faster than ever before. With initiatives such as smart manufacturing and industry 4.0 enabling the use of new technologies, the urgency to innovate and scale has never been clearer.

As fast as things are changing, vision remains the common language between humans and machines. In a world where the power of AI and robotics harness vision capabilities beyond the human eye, where perfection is attainable through remote intelligent precision and quality assurance. You can see that world today with elementary robotics. Our vision inspection system was designed with simplicity in mind. We take great pride in delivering solutions that are easy to set up, but deliver sophisticated insights that surpass current quality standards. And with our secure cloud-based systems, deployment is in real time, from anywhere in the world. Our Prism software provides intuitive labeling so you can train, refine and implement machine learning algorithms

without being a developer. Master Anomaly Detection across production lines with elementary vision systems that utilize AI and deep learning. Ensuring issues are identified and corrected well before the product reaches customers' hands. Spot trends and perform root cause analysis with elementary's advanced classification capabilities, resulting in less scrap and higher productivity gains. The technology to improve the quality of manufactured goods is here today. Deliver the value that your customers expect with an intelligent AI vision system from elementary robotics.

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Електронне навчальне видання комбінованого використання
Можна використовувати в локальному та мережному режимі

БРИНЦЕВА Олена Василівна
ПОДОРОЖНА Аліна Олександрівна

ІНОЗЕМНА МОВА ПРОФЕСІЙНО-ДІЛОВОГО СПІЛКУВАННЯ АНГЛІЙСЬКА МОВА

Методичні вказівки до проведення практичної роботи
для здобувачів першого (бакалаврського) рівня вищої освіти 3-4 курсів
денної та заочної форми навчання за спеціальністю 174
«Автоматизація, комп'ютерно-інтегровані технології та робототехніка»

(Укр., англ. мовами)

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