

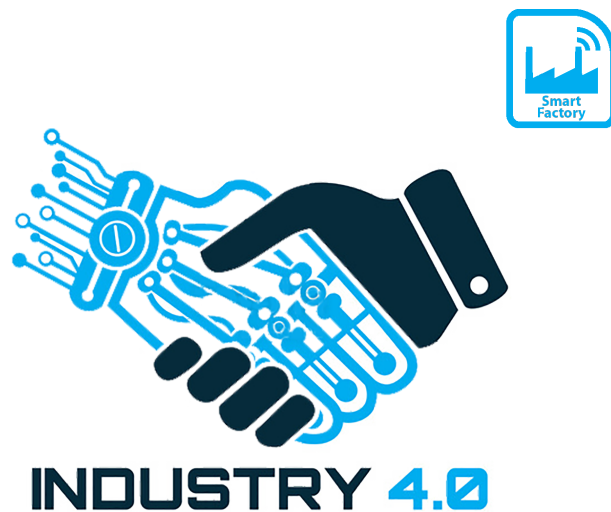
- Comprehension Questions -

# Industry 4.0 - Smart Factory TWIE24

Industrial Engineering Program

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# CHAPTER 1

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## Smart Factory - Motivation and Definition of Terms

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### 1.1 Comprehension Questions

1. Name three examples of how the future is negatively changed by the use of CPS systems:

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2. What does technological change mean for employees?

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3. Into which two areas can IoT generally be divided?

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4. What is understood by "digital transformation"?

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5. What four advantages does the Internet of Things offer companies in the Smart Factory?

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6. In which areas can an increase in productivity be achieved in a Smart Factory?

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7. How is the term Cyber-Physical System (CPS) defined in words?

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8. What is a Cyber-Physical Production System?

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9. Cyber-Physical Production Systems are increasingly being used in a Smart Factory. By which characteristics are these so-called CPPS defined?

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10. CPS platforms are the coming growth drivers in industry. What is understood by CPS platforms?

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11. Name 3 advantages that flexibilization brings to production.

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12. How can productivity growth be achieved in a company?

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13. What is understood by Smart Devices?

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# CHAPTER 2

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## Development of Automation

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### 2.1 Comprehension Questions

1. In which direction does the level of detail increase in the automation pyramid?

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2. What tasks does the enterprise management level have in a production company?

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3. What characterizes **centralized** control systems?

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4. The move away from centralized planning in the past is being replaced by decentralized architectures. What are the advantages of decentralized control of a factory?

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5. Name 5 challenges for which production companies will need to find solutions in the future.

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6. What does future development mean for employees?

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7. Give an example of why the future labor market will play an important role due to advancing technologization.

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8. Name two examples of how societal change can be steered in a positive direction through digitalization and automation.

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9. Name four advantages a user gains when switching to pay-per-use in the software domain.

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10. Name two areas in which humans are (still) superior to machines and give one example for each.

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11. Give two examples of areas in which policymakers can set the course so that as many people as possible can participate in the future world of work.

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# CHAPTER 3

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## Technological Foundations and Standards

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### 3.1 Comprehension Questions

1. Name the two most important Auto-ID techniques for objects:

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2. What does the abbreviation RFID stand for?

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3. Which two components make up an RFID system? Explain their functions.

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4. Which two barcode types are used for identification?

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5. What does the abbreviation (OMG) stand for?

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6. Which modeling languages do you know?

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7. What exactly is meant by a digital object memory, and what is the English abbreviation or translation?

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8. What is understood by the term "sensor fusion"?

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9. According to which criteria can object memories be distinguished depending on their equipment?

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10. Explain the basic technology "domain model and ontologies" with regard to autonomous action.

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11. Which three machine-processable basic technologies are crucial for autonomous action and cooperation?

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12. What challenges must sensor and actuator technologies overcome?

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13. The growing prevalence of cyber-physical systems (CPS) necessitates a heterogeneous and hierarchically organized communication infrastructure. Which three non-mobile main communication networks do you know, and what are their abbreviations?

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14. To obtain the greatest benefit from machine-to-machine technologies, the challenges in the human-machine interface in particular must be overcome. Name four challenges.

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15. Name 5 different data classes in a production facility that are relevant for human-machine interaction.

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# CHAPTER 4

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## Fundamental Concepts of a Smart Factory

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### 4.1 Comprehension Questions

1. How do production companies respond to order fluctuations?

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2. How can production resources be optimized in order-driven production?

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3. Give an example of how a company can respond to order fluctuations by means of order-driven production, and explain it.

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4. Which two classical actors operate in the value creation process?

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5. Which new actor is added?

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6. What advantages does technologization offer the employer in the field of human resources?  
Name 2 examples here.

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7. What does the abbreviation HTI stand for?

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8. What is meant by intelligent products?

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9. Why is Big Data important for smart services?

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10. Name 5 areas of human-technology interaction in production where the user is at the center.

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11. What is meant by "Predictive Maintenance"?

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12. Name 5 general challenges that arise from the use of intelligent products.

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13. What benefit can customers derive from smart services? Also give an example.

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14. Give two examples of how the collection of data along the production line enables new, individualized services.

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# CHAPTER 5

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## Reference Architectures

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### 5.1 Comprehension Questions

1. What is meant by a reference architecture?

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2. In which areas are reference architectures used in the production process?

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3. Which institutions strive to put reference architectures on a common basis? Name at least three.

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4. Name two standardization organizations at the national (German) level and give their full designation.

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5. Name three international standardization initiatives.

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6. Which areas are specifically affected by reference architectures in the production process for products, factories, and processes?

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7. What does ISO stand for?

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8. What does the RAMI 4.0 model mean in your own words?

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9. Name 3 objectives of the RAMI4.0 reference architecture:

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10. Into which three axes (levels) can the RAMI 4.0 model basically be divided, and what are they called?

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11. What is meant by the product life cycle?

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12. Explain the term showcase factory.

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# CHAPTER 6

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## Smart Factory Engineering

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### 6.1 Comprehension Questions

1. What is meant by CASE?

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2. Name the 2 classes of engineering tools:

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3. Name the two most important areas in which engineering tools provide benefits, and give two examples of each.

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4. Name 3 goals of Virtual Engineering:

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5. What is meant by UCD?

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6. What disadvantage does UCD have with regard to development costs?

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7. Name 5 examples of intelligent components in cyber-physical systems.

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8. Name 5 examples of how a product can be designed to be user-friendly.

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9. What is meant by Requirements Engineering?

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10. The characteristics of a good specification are documented in what is known as a requirements specification document (Pflichtenheft), which should contain the requirements specification, an overview of the solution, and the elements of project execution. Give 5 quality characteristics.

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11. What is meant by modeling?

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12. What advantages do intelligent products offer?

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13. Into which 3 core elements can the solutions for intelligent products be divided?

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# CHAPTER 7

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## Digital Twin

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### 7.1 Comprehension Questions

1. How is a digital twin defined?

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2. What different types of digital twins are there?  
Name at least three.

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3. What three parts does a digital twin consist of?

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4. Name two opportunities and two risks each associated with the use of digital twins.

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5. What possibilities are conceivable in the future?

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6. Name 3 future challenges of digital twins:

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7. What does the Digitalization Index indicate?

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8. How does the optimization cycle of the digital twin proceed?

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# CHAPTER 8

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## Security Risks in the Smart Factory

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### 8.1 Comprehension Questions

1. What two risk areas do you know of in Smart Factories?

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2. Why are production plants particularly vulnerable from a security standpoint?

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3. What is the BMWi?

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4. Name 3 recommendations for action by the BMWi against hacker attacks?

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5. For which 3 areas are new solutions to be found using creativity techniques?

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6. What is the name given to the collected techniques that lead to idea generation?

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# CHAPTER 9

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## Sustainability in Production

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### 9.1 Comprehension Questions

1. How can the term sustainability be described?

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2. What are the consequences of the missed opportunity for sustainability?  
Name at least three.

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3. What types of sustainability exist?

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4. Name two opportunities and two benefits of a sustainable product policy, respectively.

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5. What are the goals of sustainable production? Name at least three:

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6. Name 3 alternative environmental and efficiency technologies:

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7. Briefly explain the Product Carbon Footprint concept.

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8. What is Sustainable Supply Chain Management?

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9. Briefly explain the circular economy and name three benefits.

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10. Briefly explain what material flow management is. Which steps are required to create the flow diagram of a material flow analysis?

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11. Why is Siemens a pioneer in the topic of sustainability? Which measures were taken to reduce emissions? Name three.

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# CHAPTER 10

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## Smart Logistics

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### 10.1 Comprehension Questions

1. Name four advantages of digital transformation in the field of logistics:

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2. How can logistics meet increased customer requirements?

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3. Name three ways in which logistics can achieve greater customer orientation with the help of IT:

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4. What characterizes Digital Supply Chain Management?

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5. How do Predictive Analytics and Prescriptive Analytics differ?

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# CHAPTER 11

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## IO-Link

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### 11.1 Comprehension Questions

1. At which automation level are IO-Link sensors and actuators located?

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2. Who develops and administers the IO-Link brand?

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3. In which operating modes can IO-Link sensors be operated?

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4. What different data does an IODD contain?

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5. Which different data are sent cyclically, and which data packets are sent acyclically?

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6. What advantages does IO-Link technology offer?

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# CHAPTER 12

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## Predictive Maintenance

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### 12.1 Comprehension Questions

1. How does predictive maintenance differ from preventive maintenance?

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2. What role does the Industrial Internet of Things (IIoT) play?

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3. What does Remaining Useful Life (RUL) describe?

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4. What three forecasting approaches exist for determining RUL?

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5. Why is data quality crucial for predictive maintenance?

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6. Name two challenges of predictive maintenance.

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# CHAPTER 13

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## Machine Learning in Industry

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### 13.1 Comprehension Questions

1. How is Machine Learning defined?

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2. Which three steps does the basic learning process comprise?

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3. Why is a model's ability to generalize important?

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4. Which three learning paradigms are distinguished?

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5. How does Supervised Learning differ from Unsupervised Learning?

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6. Why is high data quality crucial?

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7. Name three model types in Machine Learning.

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8. Why is Information Fusion relevant in industry?

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# CHAPTER 14

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## Semiconductor Industry

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### 14.1 Comprehension Questions

1. How is silicon differentiated and used according to purity level in the script?

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2. Into which three application areas is the Smart Factory divided with respect to semiconductors?

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3. What is the primary goal of photolithography in chip manufacturing?

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4. What core tasks do Wacker Chemie, Siltronic, and ASML perform in the supply chain?

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5. What does the abbreviation "RUL" mean, and what three approaches exist for determining it?

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# CHAPTER 15

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## Robotics in the Smart Factory

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### 15.1 Comprehension Questions

1. What is the central role of robotics in the Smart Factory?

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2. In which decade were the first industrial robots introduced?

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3. How does ISO 8373:2021 define an industrial robot?

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4. What degrees of freedom does a rigid body have in three-dimensional space, and what movements are these?

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5. Name three typical tasks of industrial robots in industry.

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6. Which type of robot is particularly suitable for high-speed pick-and-place tasks in the food industry?

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7. What advantages does the use of cobots offer in industrial production?

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8. What special feature do palletizing robots have with regard to tool orientation?

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