Chalmers University of Technology, Department of Industrial and Material Sciences
Written examination for PPU 161 - Production Systems (2024-10-31)

Page 1 of 3

Written Examination
Production Systems (PPU161)

Date:	Thursday 2024-10-31
Time:	8:30 AM – 12:30 AM (4 hours)
Examiner:	Professor Johan Stahre (+46 703 088 838)
Place:	M Building MA,MB or MC
Questions:	The examiner or course assistant will be available for questions on phone and on two occasions in the room.
Department:	IMS, Division of Production Systems
Review of exam:	Contact the examiner

EXAM RULES AND INSTRUCTIONS:

- Communicating and collaborating with others is strictly forbidden.

- Write clearly and legible. Illegible text will be disregarded in the grading process.

- Clearly motivate your solutions to enable maximum points for each question.

- Answer only **one question per page**, sub-question may be answered on the same page.

- Write your exam code on each page of the exam. Do not write your name on any of the pages.

- Do not use a red pen.

INFORMATION ON EXAM MARKS:

A maximum of 20 points can be obtained on this written exam.

Final marks are given according to the following scheme, which represents the total sum of points from the written exam and extra points from other deliverables of the course:

- Not passed   0 − 7 points
- 3 = passed   8 – 11 points
- 4 = very good   12 – 16 points
- 5 = excellent   17 – 20 points

We wish you the best of luck!

Chalmers University of Technology, Department of Industrial and Material Sciences
Written examination for PPU 161 - Production Systems (2024-10-31)

Page 2 of 3

Production Systems (PPU161) exam

1 *Industrial revolutions – from traditional to digital systems* *Total: (2p)*

1.1 The Industry 5.0 concept has been proposed by the European Commission and includes Sustainability, Resilience, and Human-Centredness. **Please describe how Human-Centred Manufacturing systems can be developed.** (2 pt)

2 *Sustainability Thinking* *Total: (3p)*

The waste hierarchy is a useful tool to prioritize strategies and practices for waste management:

> **A. Waste prevention, avoidance, reduction (dematerialization)**
> **B. Reuse, recycling and waste treatment (circular strategies)**
> *C. Other recovery (energy recovery) and final disposal (landfill)*

2.1 Provide an example of specific digital solution to help manufacturing companies implement waste management strategy **A** in production (at factory level). (1p)

2.2 Provide an example of specific digital solution to help manufacturing companies implement waste management strategy **B** in the product life cycle. (1p)

Similarly, the energy hierarchy helps prioritize practices for energy efficiency and decarbonization:

> **a. Energy demand minimization and energy efficiency**
> *b. Shift to renewable or carbon-neutral energy sources*
> *c. Carbon offsetting*

2.3 Provide an example of specific digital solution to help manufacturing companies implement energy management strategy **a** in production (at factory level). (1p)

3 *Digital Twins* *Total: (4p)*

3.1 Explain the difference between Digital Prototype, Digital Model, Digital Shadow, and Digital twin (2p)

3.2 Give two examples of how Digital Twins can improve manufacturing systems. Motivate what is gained by using a Digital Twin in the respective example (2p)

4 *XR in Manufacturing* *Total: (1p)*

4.1 How can extended reality (XR) technologies enhance human-centric approaches in production environments? Provide two real-world use cases to support your answer. (1p)

Chalmers University of Technology, Department of Industrial and Material Sciences
Written examination for PPU 161 - Production Systems (2024-10-31)

Page 3 of 3

5   Digital Platforms   Total: (2p)

5.1   Define both pipeline and platform business models and explain
the difference between this two models. (1p)

5.2   Describe Metcalfe's Law and explain how it relates to digital platforms. *(Think of how network effects are essential for the success of platform business models)* (1p)

6   Automation   Total: (4p)

6.1   Describe 2 cognitive and 2 physical levels of automation,
explain all 4 with examples (2pt)

6.2   What are the different factors influencing task allocation?
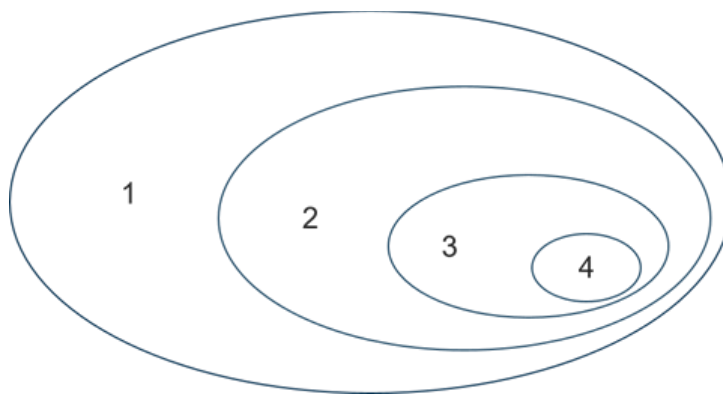List a minimum of 4 and explain them. (2pt)

7   Data   Total: (4p)

7.1   The CRISP-DM (Cross-Industry Standard Process for Data Mining) is a widely-used methodology in data science projects and is particularly relevant in manufacturing industries.

Describe each steps of the CRISP-DM process in the context of a manufacturing engineering problem (e.g., equipment maintenance, quality control, etc.) and explain why following a structured process is important. Provide specific examples for what step(s) can be the most critical for achieving successful outcomes in manufacturing environment (2pt).

7.2   Given the following image illustrating the relationships between concepts like Data Science, Artificial Intelligence, Machine learning, and Deep learning. Match each concept to each number in the image and motivate your matching (2pt).

—— *END OF EXAM* ——