Higher National Certificate/Diploma Assessment

Qualification	Pearson BTEC Higher Nationals for England (2024)

Unit number and title	4016: Instrumentation and Control Systems (L4)
Assignment title	Process Control, Systems and Controllers
Assessor	Engineering Team

Academic year	1	Unit Code	T/651/0733	Assignment	1 of 2
Internal Verifier	Dr. Michael Shaw	Verification Date		1st September 2025	
Issue Date	1st September 2025	Final Submission Date		No later than 31st August 2026	

Policy on the Use of Artificial Intelligence (AI)

- Students are required to acknowledge the use of AI in the preparation of any assignment.
- AI tools **may be** permissible for use as learning aids, subject to the AI Assessment Scale designation given below.
- AI cannot be used to generate the final, submitted work in its entirety.
- AI cannot be used to substitute for a student's own critical thinking, analysis, and original expression.
- Assignments must reflect the student's original thought and understanding.
- Assignments are checked automatically on submission for AI content, through Turnitin.
- Assignment grades are only confirmed following viva voce examination at the end of each unit.

Artificial Intelligence Assessment Scale (AIAS)

Full details of the Artificial Intelligence Assessment Scale (AIAS) are available at this link.

The AI Assessment Scale (AIAS)

Level	Description	Guidelines
1 NO AI	The assessment is completed entirely without AI assistance in a controlled environment, ensuring that students rely solely on their existing knowledge, understanding, and skills.	**You must not use AI at any point during the assessment. You must demonstrate your core skills and knowledge.**
2 AI PLANNING	AI may be used for pre-task activities such as brainstorming, outlining and initial research. This level focuses on the effective use of AI for planning, synthesis, and ideation, but assessments should emphasise the ability to develop and refine these ideas independently.	**You may use AI for planning, idea development, and research. Your final submission should show how you have developed and refined these ideas.**
3 AI COLLABORATION	AI may be used to help complete the task, including idea generation, drafting, feedback, and refinement. Students should critically evaluate and modify the AI suggested outputs, demonstrating their understanding.	**You may use AI to assist with specific tasks such as drafting text, refining and evaluating your work. You must critically evaluate and modify any AI-generated content you use.**
4 FULL AI	AI may be used to complete any elements of the task, with students directing AI to achieve the assessment goals. Assessments at this level may also require engagement with AI to achieve goals and solve problems.	**You may use AI extensively throughout your work either as you wish, or as specifically directed in your assessment. Focus on directing AI to achieve your goals while demonstrating your critical thinking.**
5 AI EXPLORATION	AI is used creatively to enhance problem-solving, generate novel insights, or develop innovative solutions to solve problems. Students and educators co-design assessments to explore unique AI applications within the field of study.	**You should use AI creatively to solve the task, potentially co-designing new approaches with your instructor.**

This assignment is based on the AIAS level indicated by the colour above.
Follow the instructions for that level.

If the submitted work falls outside the scope of the AIAS designation above, the assignment will be failed.

References

- Prepare your references and correctly cite them within the body of your assignment using zbib.org.
- Use the Harvard referencing standard of any of the listed UK universities.
- In zbib.org, create a 'Link to this Version' and copy it into your References section.
- **Assignments will be rejected if this process is not followed correctly.**

Submission Format

All text elements of your submission should be word processed, mathematical solutions can be handwritten (neatly) and scanned into your document.

Assignment Format

- **Organisation**: Use clear headings, paragraphs, and sub-sections, to ensure clarity and ease of reading. Refer to Task numbers or sections to make it clear which question you are answering.

Assignment Structure

Your assignment **MUST** include the following sections:

- **Cover Page**: Your Course, Name, Unit Name and Assignment number/name
- **Contents Page**: List tasks or questions with page numbers.
- **References**: Correctly cite and list all sources used, but do not use Wikipedia. Please see the detailed advice on page 1.

Submission Requirements

By submitting your assignment, you confirm the following:

- **Originality**: The work is your own, with all sources properly cited.
- **Plagiarism**: You acknowledge that plagiarism and collusion are forms of academic misconduct and are strictly prohibited.
- **Plagiarism Detection**: Your assignment will be submitted to TurnItIn, a plagiarism detection service, that compares your work against databases, online sources, and other students' work.
- **False Declaration**: Making a false declaration is academic misconduct.

Vocational Scenario or Context	You are a newly appointed Process Engineer in a canned food manufacturing plant and your Engineering Manager has informed you that you are required to undertake several tasks regarding the instrumentation within the plant. You need to demonstrate good understanding of the individual subject areas before you are assigned to active production projects. Your manager has therefore set you the following tasks to determine your level of knowledge. **Produce a written report for the following tasks. Include any relevant sketches, diagrams and photographic images as required. Ensure you include references to any external sources used.**

Task 1	a) For use in general process control throughout the plant, state the nature of: (i) Three types of sensor (ii) Three types of transducer For use within the plant, identify and explore TWO applications for sensors and TWO applications for transducers. c) Describe how each of the six devices you selected in Task 1(a) works. Then analyse the accuracy requirements for these sensors and transducers in one specific process used in the canned-food manufacturing plant (for example: sterilisation temperature control, filling level control, pressure monitoring, or conveyor speed regulation). Explain: • How accurate the devices must be for the chosen process • Why this level of accuracy is important for safety, quality, or efficiency • What could happen if the accuracy is too low Use clear examples from the plant to support your analysis. c) Define each of the following process control signal terms: (i) Drift (ii) Sensitivity (iii) Resolution d) Explain each of the following signal conversion techniques: (i) Analogue-to-digital (ii) Digital-to-analogue

	e) Explain TWO industry-standard signal ranges. f) By undertaking fully referenced research, provide a detailed critical review of an instrumentation and control process used within the canned food manufacturing plant

Task 2	a) Explain why process control systems are necessary in a canned-food manufacturing plant. Give two clear examples of where process control helps the plant operate safely, efficiently, or with good product quality.
	
	b) Define the following process-control terms in your own words:
	
	     • Set Point
	     • Measured Value
	     • Error Signal
	     • Proportional Control
	     • Integral Control
	     • Derivative Control
	
	Provide short examples from the plant where useful.
	
	c) A temperature-controlled room in the plant uses a PID controller to keep conditions stable.
	Explain how the PID system works in this situation.
	
	Your explanation should cover:
	
	     • The role of the Set Point, Measured Value, and Error
	     • How P, I, and D actions affect the temperature
	     • How the controller changes the heating/cooling output
	     • What happens if one of the terms (P, I or D) is set too high or too low
	
	d) Explain how you would tune the PID controller used in Task 2(c).
	
	Include:
	
	     • Why tuning is important
	     • A clear step-by-step method (such as trial-and-error or Ziegler–Nichols)
	     • Signs that tuning is incorrect (e.g., oscillation, slow response, overshoot)
	     • How changes to P, I and D affect the behaviour of the control system
	
	Support your analysis with diagrams or examples.
	
	e) Choose one industrial process from the plant, such as cooker temperature control, conveyor-speed control, pressure regulation, or automated filling.
	Analyse how the process control system operates, including:
	
	     • The sensors and actuators used
	     • The type of controller
	     • The feedback method
	     • How the system maintains safe and stable operation
	
	Support your analysis with diagrams or examples.

f) For the industrial process you analysed in Task 2(e), propose technical recommendations to improve performance, safety, or efficiency.
Explain clearly:

- Why your improvements are needed
- How they would benefit the control system
- Any risks or limitations to consider

Sources of information to support you with this Assignment	Bolton W. (2021) Instrumentation and Control Systems. 3rd Ed. Elsevier. Dabney J.B. and Harman T.L. (2003) Mastering Simulink. Prentice Hall. Dorf R.C. and Bishop R.H. (2022) Modern Control Systems. 14th Ed. Pearson. Essic J. (2018) Hands-On Introduction to LabVIEW for Scientists and Engineers. 4th Ed. Oxford University Press. Iqbal K. (2020) A First Course in Control System Design. 2nd Ed. River Publishers. Kondratenko Y.P, Kuntsevich V.M., Chikrii A.A. and Gubarev V.F. (2021) Advanced Control Systems – Theory and Applications. 1st Ed. River Publishers. Moore H. (2019) MATLAB for Engineers. 5th Ed. Pearson. Nagrath I.J. (2022) Control Systems Engineering. 7th Ed. New Age International Publishers. Nise N.S. (2011) Control Systems Engineering. 6th Ed. John Wiley & Sons. Sarangapani J. and Xu H. (2021) Optimal Networked Control Systems with MATLAB. CRC Press. Cappelli M. (2023) Instrumentation and Control Systems for Nuclear Power Plants. 1st Ed. Woodhead Publishing.

Relevant Learning Outcomes and Assessment Criteria

	Pass		Merit		Distinction
LO1	*Describe operation of instrumentation devices including parameters used in process control*			**LO1**	
P1	Describe operation of the key types of sensor and transducers used in process control.	**M1**	Explore industrial applications for sensors and transducers.		
P2	Define the signal terminology used in process control.			**D1**	Critically review the industrial application of an instrumentation and control process system, using research evidence.
P3	Explain the different methods and standards used in signal conversion and conditioning.	**M2**	Analyse the accuracy of the sensors and transducers used in a particular application.		
LO2	*Investigate process control systems and controllers*			**LO2**	
P4	Investigate the importance of process control systems.	**M3**	Analyse a typical industrial application for a process control system.	**D2**	Propose recommendations for improvements to process control systems and controllers.
P5	Explore the process controller terminology used in industrial applications.				