

Higher Nationals

Assignment Brief – BTEC (RQF)



Qualification	Pearson BTEC Higher National Diploma in Mechanical Engineering
Student Name /ID Number	
Unit Number and Title	Unit 78 Programmable Logic Controllers
Academic Year and Batch	2024/ Batch 1 (Part Time)
Unit Assessor	Mr. Virantha E. A. I
Assignment Title	The application of programmable logic controllers to enhances the productivity, efficiency, and safety of a production plant.
Issue Date	02/6/2024
Formative Assessment	10/9/2024
Submission Date	25/9/2024
IV Name and Date	Mr. Janaka Perera

SubmissionFormat:

The submission is in the form of an individual written report. Written report be written in a concise, formal business style, using single spacing and font size 12. You are required to make use of headings, paragraphs and subsections as appropriate and all work must be supported with research and referenced using the Harvard referencing system. Provide a bibliography using the Harvard referencing system

Unit Learning Outcomes:

LO1 Describe the design, operation and selection of PLC systems

LO2 Explore Functional Safety within PLC systems

LO3 Develop a PLC program for an automated process system

LO4 Review how PLCs exchange information and process signals with other devices

Scenario

Assume you are the newly appointed mechanical engineer at a conventional automotive assembly plant. This plant is quite old, and the technology used in here is outdated, resulting in comparatively low production rate. Most of the assembly works done by manually. Because of these reasons they are running at a loss, so the plant owner wants to introduce new technology to improve production efficiency and product rate. He plans to do this by introducing automation technology, but he doesn't have the required knowledge to implement it, and even the current technicians lack knowledge in automation. Therefore, he has recruited a young, energetic, and knowledgeable engineer for this task. Assume that this is you, and help the plant owner to automate the factory by working with the other technicians

Part 1

- (a) While working on this project, you always needed to train the technicians under your supervision. Imagine you are in such a training program, and some technicians are asking you a few questions.
 - i) One technician asks you to describe the PLC's internal architecture and its operation. Using a sketch, explain the PLC's internal architecture, the PLC scan cycle, and how it operates.
 - ii) Another technician asks you to explain the differences between compact, modular, and rack-mounted PLCs. Compare and contrast these types of PLCs, providing three applications for each.
 - iii) Another technician asked about the different types of input and output devices that can be connected to a PLC. Provide your answer, and also describe the interfacing techniques used for connecting these input and output devices to the PLC.
- (b) It was suggested to design the plant with twenty-five automotive assembly points using vision-guided assembly robots. Analyse the suitability of using programmable logic controllers (PLCs) versus programmable automation controllers (PACs) for this application.
- (c) Automotive body parts are painted before the assembly. This painting is done inside a painting booth, where temperature and humidity must be closely monitored and controlled. It is recommended to use PID controllers to regulate both temperature and humidity. The exhausted air from the painting booth is controlled by a VSD-driven fan. All parameters should be displayed on an HMI. The entire system will be controlled by a PLC. What specifications are needed for the PLC, and justify your answer? Additionally, suggest a Siemens PLC type suitable for this application.

Part 2

- (a) Assume you are in technician training program,
- Explain what is the goal of functional safety within industrial PLC systems and give three examples for functional safety feature use in industrial PLC systems for them.
 - One of the technicians ask to list the IEC6113-3 stranded programming languages and compare these languages and their applications. Give your answer.
- (b) The following automated system (Figure 1) is used to transfer engine body parts from a magazine onto a chute. When push button is pressed, the first cylinder extends, pushing part from the magazine and positions it in preparation for transfer by the second cylinder onto the out-feed chute. Once the part is transferred the first cylinder retracts followed by the second. Figure 2 shows the pneumatic circuit design for this system and Figure 3 shows the PLC ladder logic program written for this process.

Do the functional safety analysis for above PLC based system and state your comments and give suggestions to improve the functional safety of the system

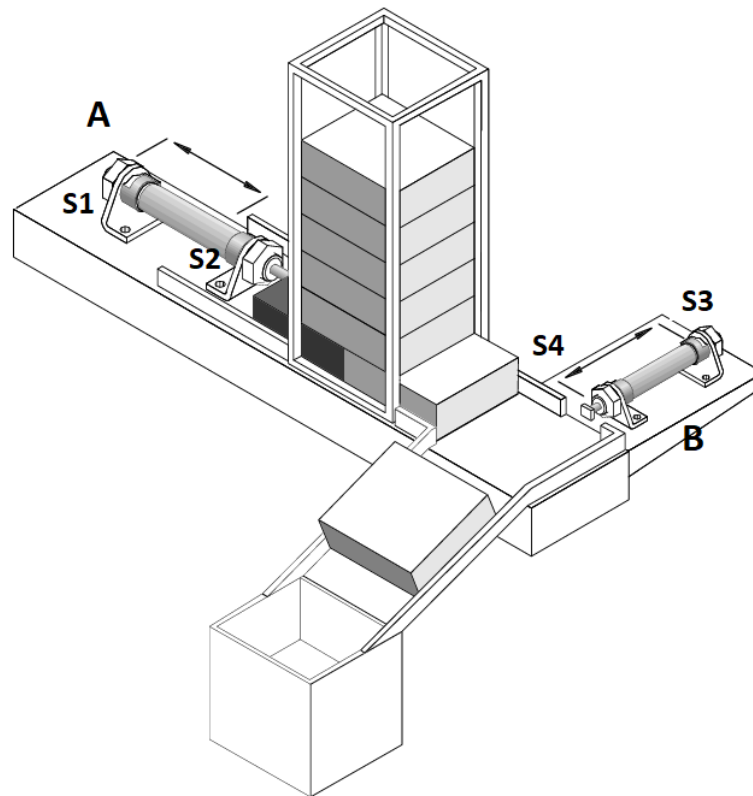


Figure 1

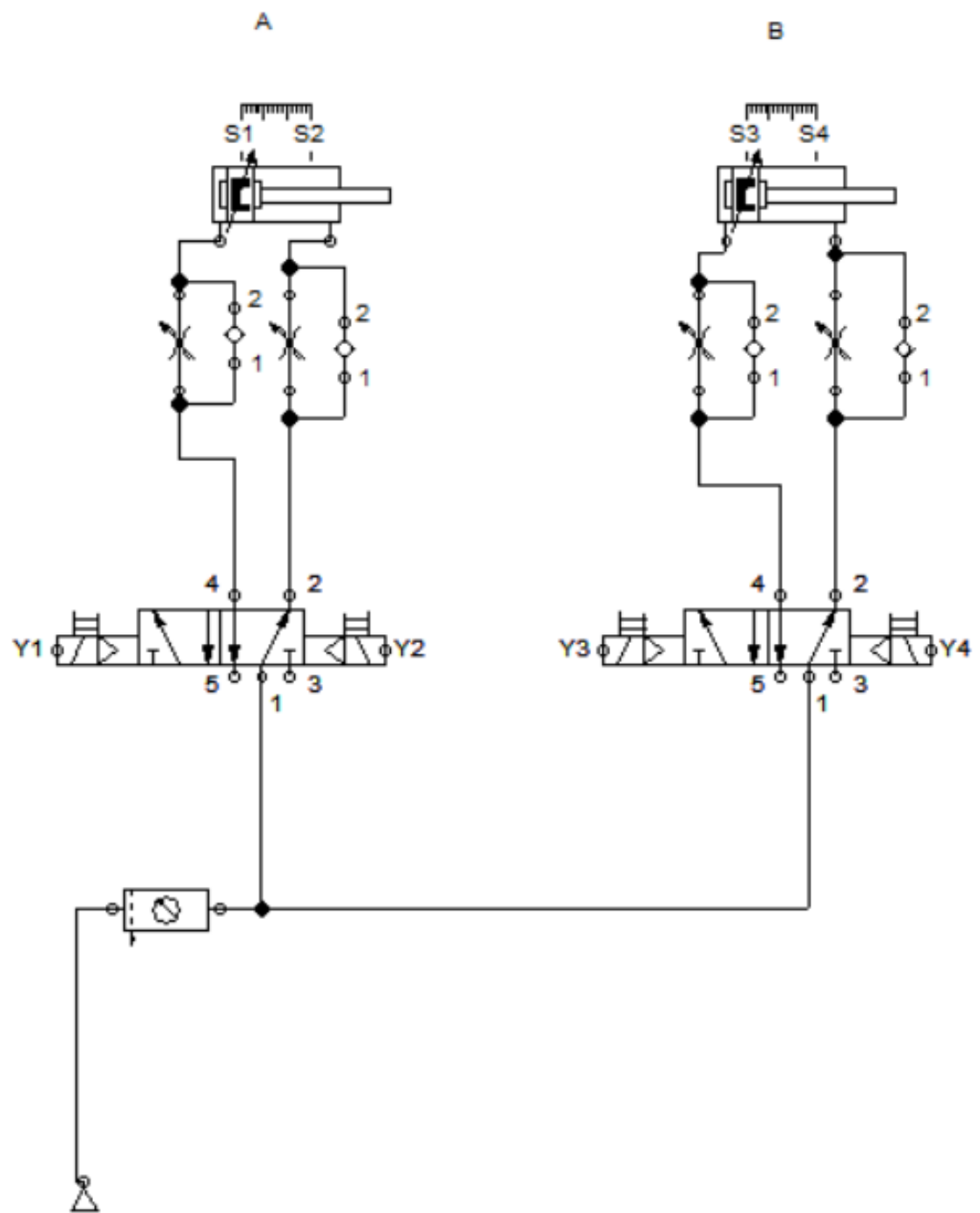


Figure 2

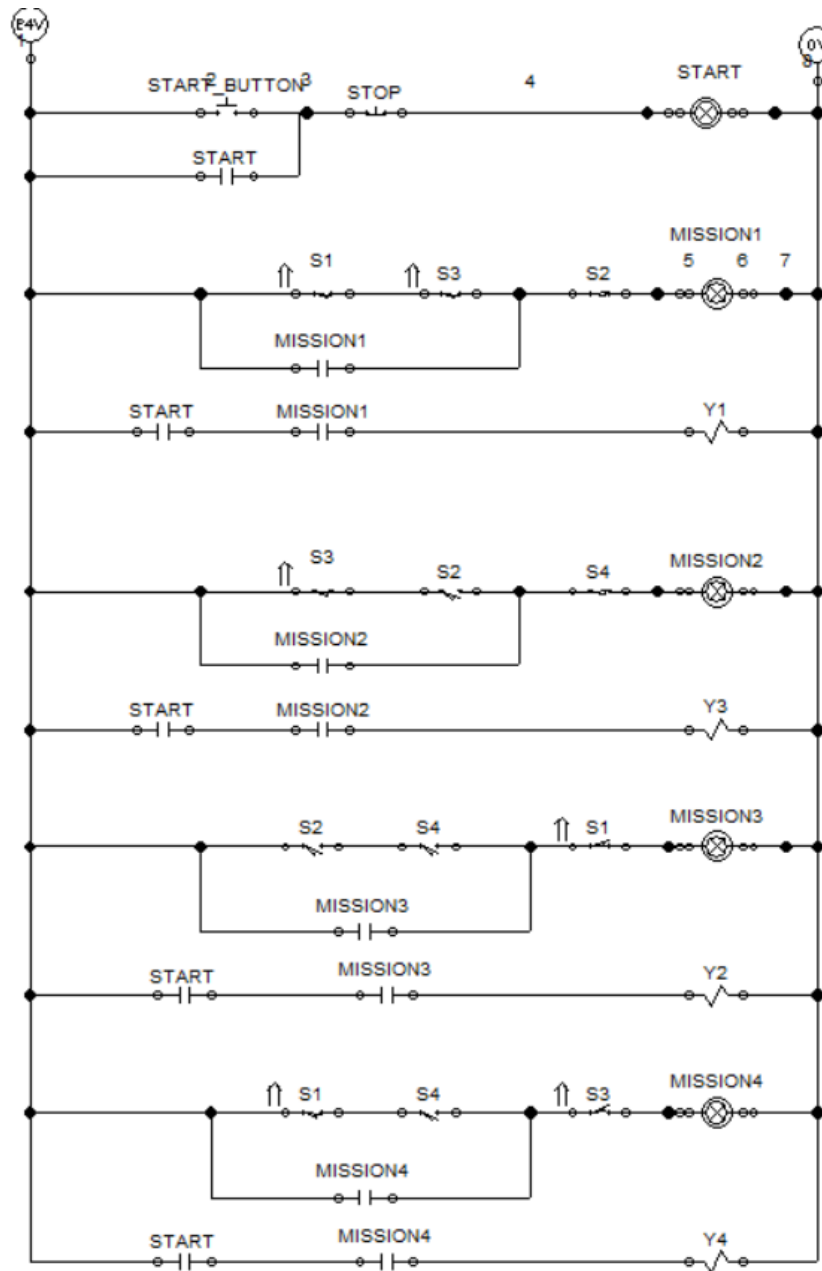


Figure 3

- (c) Prepare a one-page document for your boss evaluating functional safety and its integration within PLC systems to mitigate hazards and risks.

Part 3

(a)

- i) Figure 4 shows the logic gate circuit used for a specific automotive assembly operation. As a part of plant automation project this circuit needs to be replaced by a PLC with a ladder logic program. Therefore, translate the following digital logic control circuit into an equivalent PLC ladder logic program.

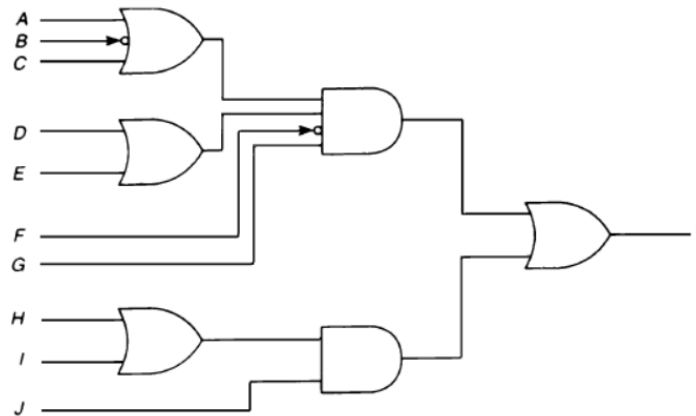


Figure 4

- ii) In a certain automotive assembly operation hole has to be machine in a vehicle engine part. The operation as follows. while placing the engine part the contact switch is activated and produces the stating signal for the automated process. Then clamping cylinder extract and clamp the engine part and it increases the clamping force until the cylinder pressure reaches 6 bar. Then drilling cylinder begins to extract and at the begging of extraction drilling motor also starts. Drilling cylinder extract until it reaches the cylinder front end reed switch. Then it backwards and when it reaches to back position drilling motor switch off. Then clamping cylinder backwards and engine part can be removed. The Figure 5 shows the schematic diagram of the setup used. For this operation prepare a design and planning documentation associated with the developing of a PLC program.

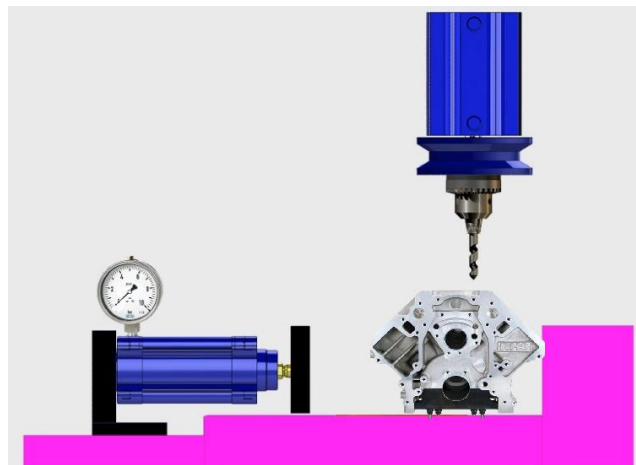


Figure 5

iii) based on above developed Planning documentation develop a functionally safe PLC program for above automated process.

(b) Apply methods of testing and debugging hardware and software for above PLC system.

(c) The engine oil required for the engines is stored in a tank near the engine testing room. Oil is pumped into this tank from an external reservoir as shown in Figure 6. The tank contains two sensors to detect high and low oil levels. Until now, the pump has been operated manually by an operator monitoring the level indicator lights. As part of the plant automation project, it was proposed to automate this manual system. Consequently, one of the technicians developed the PLC ladder program shown in the Figure 8. Please evaluate this PLC ladder logic program and suggest any necessary modifications.

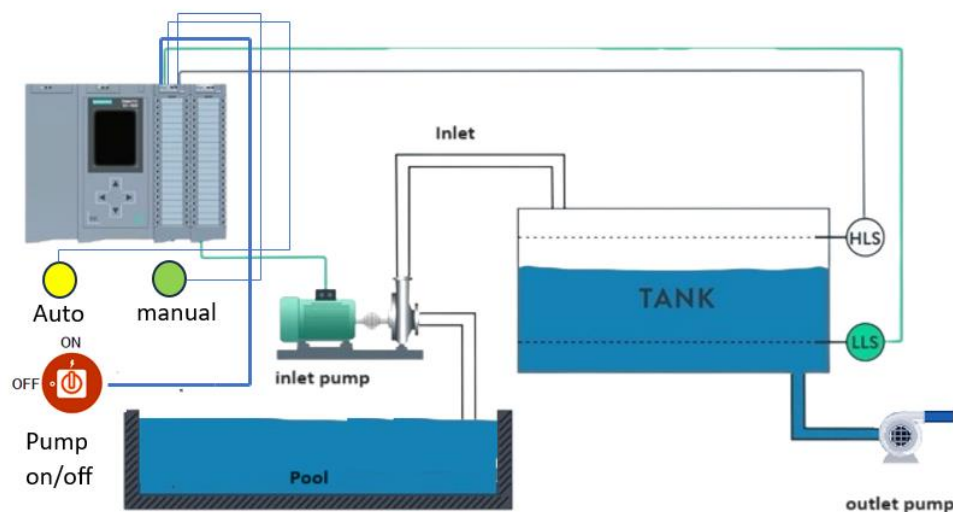


Figure 6

Symbol	Address	Comment
Auto_PB	I0.0	Push button to put the operation to Automatic mode
Manual_PB	I0.1	Push button to put the operation to manual mode
Auto_Mode	M0.0	Auto mode memory bit
Manual_Mode	M0.1	Manual mode memory bit
tank_low_level_sensor	I0.2	tank oil level is in low detecting sensor
tank_high_level_sensor	I0.3	tank oil level is in high detecting sensor
Pump_On	Q0.2	out put to the pump contactor
Pump_On_PB	I0.4	Manual pump on push button
Pump_Off_PB	I0.5	Manual pump off push button
Tank_Level_high_indicat	Q0.3	output to the indicator bulb (oil level in in high)
Tank_Level_low_indicat	Q0.4	output to the indicator bulb (oil level in in low)

Figure 7

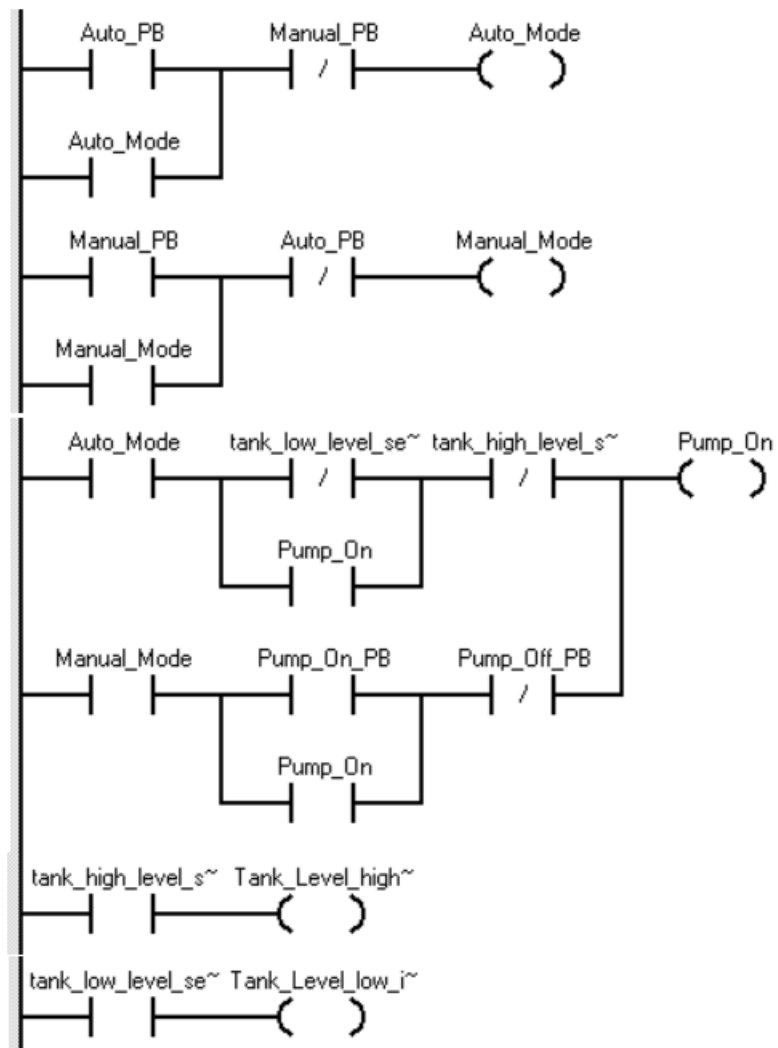


Figure 8

Part 4

(a)

- i) One of the technicians working with you ask to Describe the characteristics and methods of digital data communication for PLCs. What is you answer.
- ii) He also asks to explain the common Fieldbus communication methos available in PLCs and to give review of each protocol. what is the answer you are giving him.

(b) The proposed automated plant includes several branches, such as body assembly, engine assembly, engine testing, auto wiring, painting, and finishing. Each branch is equipped with automated robots and machinery. The plant owner has suggested implementing centralized high-level supervision and control for each process. First, he wants to evaluate the use of a SCADA system for the plant. So, Assess the importance and benefits of the use and integration of SCADA and HMIs with PLCs in this plant and prepare a one-page report for him.

(c) prepare a one-page report to the plant owner evaluating the Fieldbus and Ethernet Technologies for industrial manufacturing applications and suitability of applying technology for the plant.

Learning Outcomes and Assessment Criteria			
Learning Outcome	Pass	Merit	Distinction
LO1 Describe the design, operation and selection of PLC systems	<p>P1 Describe the architecture and operation of programmable logic controllers</p> <p>P2 Compare the design and applications of Compact, modular and rack-mounted PLCs</p> <p>P3 Describe the range of input/output devices and PLC interface techniques</p>	M1 Analyse the suitability of programmable logic controllers (PLCs) with programmable automation controllers (PACs) for given applications	D1 Justify the selection of a programmable logic controller for a given application
LO2 Explore Functional Safety within PLC systems	<p>P3 Explore the requirement of functional safety within industrial PLC systems</p> <p>P4 Compare the range of IEC6113-3 languages and their applications</p>	M2 Apply functional safety analysis on a PLC based automated process system	D2 Evaluate functional safety and the integration of functional safety within PLC systems to minimise hazards and risks
LO3 Develop a PLC program for an automated process system	<p>P5 Translate a digital logic control circuit into an equivalent PLC program.</p> <p>P6 Produce design and planning documentation associated with the preparation of a PLC program.</p> <p>P7 Design and develop a functionally safe PLC program for an automated process system</p>	M3 Apply methods of testing and debugging hardware and software in PLC systems	D3 Evaluate the PLC program for an automated process system and make justifiable modifications

<p>LO4 Review how PLCs exchange information and process signals with other devices.</p>	<p>P8 Describe the characteristics and methods of digital data communication for PLCs</p> <p>P9 Review common communication technologies available on a range of PLCs</p>	<p>M4 Assess the use and integration of SCADA and HMIs with PLCs in industry</p>	<p>D4 Evaluate Fieldbus and Ethernet Technologies for industrial manufacturing applications</p>
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STUDENT ASSESSMENT SUBMISSION AND DECLARATION

When submitting evidence for assessment, each student must sign a declaration confirming that the work is their own.

Student name:		Assessor name:	
Issue date:	Submission date:		Submitted on:
Programme:			
Unit:			
Assignment number and title:			

Plagiarism

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Student Declaration

Student declaration

I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice.

Student signature:

Date:

Student Name/ID			
Unit Title			
Assignment Number		Assessor	
Submission Date		Date Received 1st submission	
Re-submission Date		Date Received 2nd submission	
Formative Comments:			
Assessor Signature:			Date:
Assessor Feedback			
Grade:	Assessor Signature:		Date:
Student Signature & Date:			

* Please note that grade decisions are provisional. They are only confirmed once internal and external moderation has taken place and grades decisions have been agreed at the assessment board.