Sample Assignment Brief

AQA Level 3 Technical Level Engineering: Mechatronic
Programming for Engineers

Tutor/Assessor Name			
Assignment Title			
Date Assignment Issued		**Submission Date**	

Task number	**Grading criteria to be evidenced in the task**
Task 1	P1, P2, P3, M1, D1
Task 2	P4, P5, P6, M2, M3
Task 3	P9, P10, P11, P12, D3, M5
Task 4	P7, P8, P13, P14, P15, P16, M2, M6, M7, M8, D3, D4

Learner Authentication

I confirm that the work and/or the evidence I have submitted for this assignment is my own. I have referenced any sources in my evidence (such as websites, text books). I understand that if I don't do this, it will be considered as a deliberate deception and action will be taken.

Learner Signature **Date**

Tutor/Assessor Signature **Date**

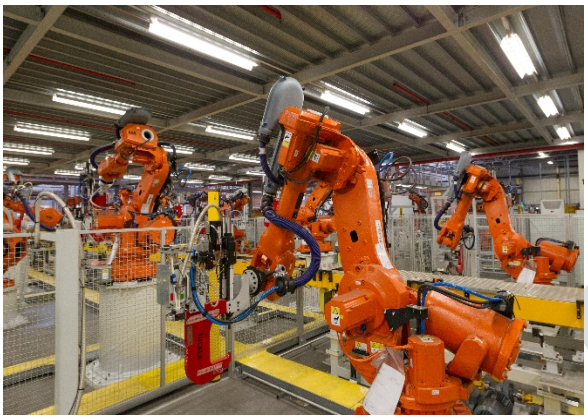
WHO IS THE AUTOMATED TECHNOLOGY GROUP?

The Automated Technology Group Ltd is the largest independent controls company in the UK. They employ staff at two locations in the UK, their headquarters in Silsoe, Bedfordshire and their robotics and simulation centre in Kings Norton, Birmingham.

Whilst the company name is not yet widely known outside the industry, within it they are a major player, and the supplier of choice for marquee brands such as Jaguar Land Rover, Bentley and BMW Mini, to design, simulate, program, install, commission and maintain advanced automated production line solutions.

Outside the automotive sector, The Automated Technology Group provide automated production and logistics solutions for Amazon, Coca-Cola, and Heathrow Airport amongst others.

ROBOT CELLS



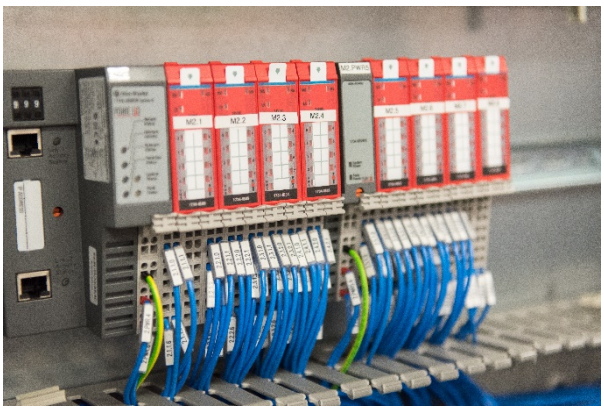
Many of the production line solutions developed and implemented by the Automated Technology Group are centred around the concept of a robot cell. This is a self-contained production cell which contains an industrial robot, and the associated ancillaries and safety equipment to enable the robot to perform its intended production operation.

For example, in automotive engineering, operations are many and various, ranging from handling the body panels, to performing measurement on them, welding them together and applying adhesive and painting.

A robot cell will nominally perform one operation, which may require one or more robots working together to complete. They will perform this operation accurately, repeatedly and reliably – removing concerns about human error, fatigue and safety, whilst increasing speed, efficiency and throughput. Once this operation is complete, the part-assembled car will be passed to the next cell for the next operation, and this cell will await the next car in to perform its own operation again.

PLC PROGRAMMING

Although the robot itself usually performs the majority of work within the cell, the sequence of cell operations including supervison of the robots, is down to a separate (but linked) control system, run by a Programmable Logic Controller (PLC).



The PLC coordinates activities in the whole cell, operating valves, actuators and motors, ensuring panels are present when required, and managing any human interactions, to ensure reliable and safe operation.

The Automated Technology Group have a large team of programmers who write the code to run on the PLC, controlling the cell, as well as looking after the wiring, installation and testing of the control panels which house the PLC and interface to all of the associated control components.

TASK OVERVIEW

Within this assignment, you will research and design the PLC system(s) which control the reliable, safe, efficient operation of a robot cell suitable for use in an automated car production environment.

This will comprise the choice and justification of PLC technology, the type of PLC to be used and the selection of a suitable programming language.

You will then program the PLC to achieve desired outcomes as specified by the assessor, subsequently testing and debugging your solutions to ensure optimal performance.

You will also need to demonstrate research skills.

ROBOT CELL PLC IMPLEMENTATION

Task 1: PO1 – Understand the role of programmable logic controllers in engineering systems and subsystems (P1, P2, P3, M1 and D1)

In order to begin using PLCs within an industrial environment, you should first demonstrate an understanding of the PLC as a piece of equipment and the various types and uses currently employed.

You should write a brief overview of Programmable Logic Controllers which should include:

- Researching the historical development or PLCs, and how they have evolved from relay logic control panels (P1).
- The advantages and disadvantages of their use, possibly by referencing non-PLC methods of industrial control (P2).
- The current applications of PLCs in no less than three organisations in different industry sectors (e.g. food & beverage, process control) (P3).

You could also compare the use of PLCs in different applications against the use of non-PLC methods (M1), and evaluate the limitations of current PLCs and the effects these could have on engineering practice (D1).

Task 2: PO2 – Understand the principles of computer programming (P4, P5, P6, M2 and M3)

Once you are familiar with the concept of PLCs and their use, the next step is to learn about their programming.

You are required to:

- List the main IEC61131-3 PLC programming languages (P4).
- Describe the benefits of a modular approach to programming (P5).
- Use when programming a number of different PLC numbering systems (eg. Decimal, Hex) (P6).

You could also select and justify a programming language which you would use for a given purpose, and within this, also explain how input/output (I/O) is achieved (M2 and M3).

Task 3: PO3 – Understand the basic operation of a PLC and its connectivity (P9, P10, P11, P12, M5 and D3)

In order to work effectively as a PLC engineer, not only should you be able to write the code, but you must be conversant with how this translates to the real world, by means of devices connected to the PLC.

This should be in the form of a design specification for the connections to be made to the PLC. This must include :

- A description of the basic configuration of a PLC controlled system for a given application, including a full I/O list for a given application (P10). You could also justify the selection of this I/O (M4).
- An explanation of how a PLC will execute a program, with specific reference to the I/O required (P9).
- How you would commission the system by using the I/O monitoring functionality of the PLC.
- Relevant health and safety concerns with setting up, testing and using the I/O devices you have specified (P11).
- The maintenance and fault-finding procedures that would be required for the I/O you have specified (P12).

You could also explain the difference between preventative and routine maintenance in this context (M5), and the limitations of the PLC system being used for the stated purpose (D3).

Task 4: PO4 – Design computer programs for use in engineering (7, P8, P13, P14, P15, P16, M2, M6, M7, D3 and D4)

You are to use the knowledge and techniques you have learned to design and program a PLC to a given specification.

The specification details are as follows:

The PLC is to be used to control a robot production cell in an automotive factory. The cell contains a robot which will be welding panels together.

The cell has the following items which need to be monitored and controlled:

- A 4-position loading turntable (only 1 and 3 used). The operator loads two small panels onto the turntable, pressing a ‘start’ pushbutton when completed. The turntable will then rotate and present this panel to the welding robot. This will present an empty position to the load station and so on. The turntable requires a pulsed digital signal for each position, to request it to move that that position, and an analogue signal to tell it what speed to turn at. It will stop automatically in position for the robot. Once in position, it will output signals as a 3 bit Binary Coded Decimal (BCD) number to indicate which of its positions it has come to rest at. This should be indicated somewhere on the PLC, or held in a register for future use. When moving, this BCD signal will indicate zero.

- The welding robot. When at ‘home’, ready to start, the robot will set a ‘home’ signal to the PLC. Once the turntable has indicated it is in place, with the robot at home, the robot will be started by a 1 second pulsed output (also resetting robot home signal). When it has finished, it will set a ‘weld work complete’ signal to the PLC, which will remain on until the robot returns to the home position. When all work has been completed the PLC will allow the robot to return home by setting an “acknowledge work complete” signal.

- A conveyor belt leading out of the cell. The robot will place the completed sub-assembly on the belt once welded. The belt must then start moving until the parts have left the cell. The robot will output a digital signal once it has completed its welding and there is a through-beam sensor on the belt to sense when the robot has placed the part down. Only when these two signals are on can the belt

begin to move. When a second through-beam sensor detects the part at the end of the belt, the conveyor should continue to run for another 10 seconds and then stop. The PLC can start the conveyor by setting a digital output, and the conveyor will run for as long as the output is set.

- The cell should count how many parts have passed through. When it reaches a predetermined number, the cell must stop for maintenance. This will be indicated by the illumination of a lamp, and cannot restart until a button has been pressed to indicate maintenance has been completed.

There is various safety equipment mounted within and around the cell, designed to immediately stop any movement and operations within the cell should an unauthorised presence be detected within. This safety equipment comprises:

- A roller shutter door on the load station. The door will open when the turntable is ready for new parts to be loaded. When opened, a door-open sensor will be set on. The PLC output to drive the roller door must be set and maintained on until the door-open sensor is set on.
- The roller door close is initiated by two-handed pushbuttons which must be operated simultaneously. Again, this will feed into the PLC which will activate an output to close the door. This must be maintained until the door-closed sensor is seen. The turntable and robot will only be enabled with the door-closed switch on, immediately halting operation if changed to off.
- The turntable must not move from the time that the door-open sensor is broken, until it is made again signifying the door is fully closed.
- A light scanner on the floor of the cell will give a positive output if the floor is clear. If the floor of the cell is not clear, the roller shutter door will be unable to close.
- Three emergency stop pushbuttons are positioned around the cell. If any of these is pushed, all operations must cease immediately. The cell cannot then restart without a full restart of the program, even if the emergency stop (e-stop) is cleared.

In this task you need to:

- Gather information from the system to produce a project specification, I/O list etc.(P13).
- Produce a PLC program to achieve this specification (P7, P8 and P14).
- Fully document the program, allowing another team member to work on it if required.
- Test the program using whatever physical and/or simulation test tools are available (P15).
- Store and backup the program as you go, showing a backup strategy and version control (P16).

You could also:

- Identify any improvements and modifications possible following testing (M8).
- Evaluate how well your system meets the requirements (D4).
- Select and justify a programming language to be used for a given purpose (M2).
- Explain the limitations of the PLC system being used (in relation to the intended purpose) (D3).
- Explain which factors influenced the design of the PLC program (M6).
- Explain how the PLC program avoids unnecessary operations (M7).

Submission Checklist (please insert the items the learner should hand in)	Confirm submission
Learner - please confirm that you have proofread your submission	

Transferable Skills

When completing this assignment, learners will be working towards the transferable skills of research – see section 6.4 of the specification document and the following area for more information about the standards and how they should be evidenced.

For this assignment the transferable skills can be evidenced in the following tasks:

Research Standards

Evidence must clearly show that the learner can:

R1	Design a research study	1.1 Identify possible topics for research 1.2 Choose one topic, identifying appropriate objectives for detailed research, and plan how to carry out the research 1.3 Select a variety of resources to gather relevant information and identify appropriate methods and techniques to carry out the research	Assignment task 1 Grading criteria: **P1 Research** the historical development of PLCs
R2	Conduct data collection and analysis	2.1 Collect data using the appropriate methods to test the hypotheses/theories 2.2. Carry out an appropriate analysis of the data 2.3 Draw appropriate conclusions that are supported by the evidence from the data analysis	
R3	Present findings of the research and evaluate the research activities	3.1 Prepare and present results of research 3.2 Present the information in a clear and appropriate format adapted to the needs of the audience 3.3 Seek feedback and use it to support own evaluation of research skills	