Coursework Assignment

6E7V0021 Programming Industrail Automation Systems

Coursework Assignment 1CWK100, 6E7V0021, Sit 2

This is an assignment for students on Level 7 of the following courses:

- MEng (Hons) Electrical and Electronic Engineering
- MSc Smart Systems Engineering

It is an opportunity for you to demonstrate your skills in problem solving, coding and understanding of Programmable Logic Control Systems. You are required to use real-time automation & control application software package called CoDeSys to develop solutions for solving control and automation problems in industrial scenarios.

Links

The unit's moodle area includes the support information, submission details, answers to frequently asked questions, and the latest version of this document.

Contacts

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Workflow

The tasks must be accomplished, and the findings are to be documented in a written report. These tasks are to assess the following:

- Assessment on cycle time in a PLC. This is to assess how parameters for cycle times affect performance of the overall control systems with Task 1.
- Assessment on programming skills in automating physical or simulated plants by creating programming objects such as Functions, Function Blocks, Visualisation graphics, and Programs. Task 2 assesses essential programming skills while Task 3 more advanced programming skills.

The method of your coursework is to utilise the **supplied data** and provide solutions to the control problems set with the tasks.

This document is also used for the unit's re-assessment with the supplied data different from the first set of data and parameters.

For the assessment you will be awarded a final mark for the unit out of 100%, and we expect you to spend as much time as you need to achieve a good understanding and a good mark.

A document template is provided and must be used to write the coursework report.

Your assignment is divided into three tasks. Make sure that you understand the related industrial applications or scenarios so that you can add extra functionality and features based on the indicative work specified in this document.

Task 1 – Electric Heater Control and Examination of Timing in a (Simulated) PLC (30%)

"Cycle times" are important concepts in an industrial controller. The cycle time of a Programmable Logic Controller is the most important timer among other timing parameters. This task will use a simulated PLC, the CoDeSys development environment. However, physical rigs can be also used. Completing this task allows further progress in completing the other coursework assignments.

Task 1 contains the following elements:

1.1 The task is to control an electric heater using pulse width modulation (PWM). Using two visual lights to indicate when the heater is on (e.g., in green) and when it is off (e.g., in yellow). The on and off duration can be adjusted. Thus, the two lights are in green and yellow for different durations. Understand the problem/requirement and design a logic as a solution. Explain your solution by using block diagram(s) and/or flowchart(s), etc. (5%).

1.2 Use CoDeSys software, develop code and visualisation to demonstrate that your logic is correct and you can examine the timing parameters by adjusting settings in the **Task Configuration** of CoDeSys (20%).

Make sure that you can adjust the Duty cycle for: Duty Cycle = 45%, 50%, or 60%.

When clicking an object button (which is created in your program), are the lights on immediately? How long does it take for the lights to be on? Are the duty cycles accurate? What parameters affect such real-time applications? To test and explain how cycle time affect the on/off performance, configure the cycle time as

PLC cycle time = T#100ms, T#5s, or T#2s.

1.3 Report writing. Explain your code/program structure, software objects, functions, settings and configurations clearly and concisely (5%).

Task 2 – Automation of a part sorting process (20%)

A simulated sorting process is provided. The sensors, A and B and actuator are working and can be tested. You are expected to develop a program using the SFC programming language to let any parts with a hole to go through and without to be moved out.

2.1 You can use the project developed during the unit's lab sessions as a starting point. Change the program to a SFC Program and develop it to a full working solution. (10%)

2.2 Expand the solution with Alarm handling functions. Simulate if Sensor B has a fault, the alarm can be detected, displayed, and acknowledged. (5%)

2.3 Report writing. Explain your code/program structure, software objects, functions, settings and configurations clearly and concisely (5%).

Task 3 –Tank Liquid Level Controls (50%)

A liquid tank with details on inlet feeding and outlet discharging will be provided as a base for this task. The operation of the tank is, for example,

- to open the water inlet valve until the tank level reaches a certain height
- to add chemicals to a certain weight
- to mix the solution for a certain time to produce the product
- to discharge the tank

Key parameters such as flowrates, the weight of the chemicals, tank dimensions, etc. will be provided. Tank level needs to be checked if it violates the Low and High alarm limits. The status of the valves, mixer, alarms, and Tank Level should be displayed.

Task 3 contains the following elements:

3.1 Work out how the liquid level changes in the tank and create code (a function block) to simulate it in CoDeSys (5%). This is an important function for the tank level controls.

3.2 Design logic to automate the operation and maintain the liquid level within the alarm limits. (15%).

3.3 Develop user graphic interface for operational status (15%).

3.4 Your program, code and visualisation functions should allow testing, debugging and commissioning on different operation conditions of the liquid tank, for example, adjusting flowrates and measurement limits. The whole operation is automated and the code adheres to good practice in software engineering. (10%)

3.5 Explain your code/program structure, software objects, functions, settings and configurations clearly and concisely (5%).

Report writing

A Word document template is provided for the report writing.

- The template must be used as it includes the headers, footers, font size and other details.
- The requirement for the length of the report is between 12 and 15 pages which exclude any appendix. Detailed source code/program and other supporting documents are included as appendices.
- Graphs, diagrams, flowcharts, and/or screenshots should be original and included in the report in the main body. Material of the other sources should be minimum and their origins clearly cited.

Pass Criteria

What you need to do to achieve a pass at threshold level (Mark of 50%)

There is clear evidence that you have attempted all the tasks and produced adequate amount of work. Especially, you can complete Tasks 1.1, 1.2, 1.3, 2.1, 2.3, and 3.2.

What you need to do to achieve a pass above threshold level (Mark above 50%)

All the tasks are completed to a good standard above the pass threshold and marked based on the Assessment Grading Criteria.

Supporting Learning Resources and Activities

The unit is practical and hands-on. The designed workshop and tutorial are important part of this unit. Attendance to the lectures, workshop and tutorial is vital to pass the assessment and to achieve higher marks.

Assessment Notes

- The assignment has been developed to assess your ability to problem-solving skills. There are more than one technique or solutions. You are expected to exercise your engineering knowledge, skills and decision-making throughout the coursework.
- Make sure that you understand the tasks and the industrial application scenarios associated with these tasks so that your techniques and solutions are expandable, realistic and of a good standard.
- Make sure that you understand and follow the guideline on the report writing.

Marking

Formative Feedback

Members of the teaching team will answer queries about the assignment during the timetabled sessions (see your personal timetable for details). The advice given during these sessions and feedback on any work you present will not count towards your final grade.

Outside timetable sessions, please email questions to the Teaching Team, the Support Tutors or your Personal Tutor. The teaching team will **not** use their office hours to provide one-to-one or small group assignment support, but a selection of emailed questions, and questions asked during the timetabled classes will be added to the Unit's moodle area.

What is being assessed?

Learning outcomes		Evidence
Unit Learning Outcomes	1. Program a PLC using the languages supported by IEC61131 standard.	Code and the coursework report
	2. Analyse the requirements of an industrial process and develop appropriate software to control it.	Code and the coursework report
	3. Virtually commission an industrial control process	Program and code
Assessment Criteria	USD 1: Apply skills of critical analysis to real world situations within a defined range of contexts. (30%) *AHEP-4 M2.*	

	USD 2: Demonstrate a high degree of professionalism* eg initiative, creativity, motivation, professional practice and self management. (20%) *AHEP-4 M6, M12.*
	USD 6: Find, evaluate, synthesise and use information from a variety of sources. (50%) *AHEP-4 M12*

To pass this assessment you have to fully achieve the unit learning outcomes by completing all the tasks and submitting the deliverables to an adequate standard. Since your degree is accredited, you also need to demonstrate evidence of obtaining UK SPEC AHEP outcomes at pass threshold levels. These are listed in full within the Appendix of this assessment brief.

Your grade will be determined by how well you meet the assessment criteria (see the detailed grading criteria for this assignment, below).

This assignment will be marked out of 100 and contributes 100% of overall unit grade.

Assessment Grading Criteria:

The grading bands are used for giving a sub-total mark for each of the three tasks as shown in the grids. Within a Task, marking is to each of the sub-tasks as the following.

Tasks	Sub-tasks	Break-down marks	Mark to be awarded
Task 1	Task 1.1	5	3
	Task1.2	20	
	Task 1.3	5	
Task 2	Task 2.1	10	
	Task 2.2	5	
	Task 2.3	5	
Task 3	Task 3.1	5	
	Task 3.2	15	
	Task 3.3	15	
	Task 3.4	10	
	Task 3.5	5	
	Total	100	

Table 1 – Marking for tasks and sub-tasks

An example of marking:

Task 1.1 is awarded 3 instead of 5, i.e., 60% in Table 1. This range is based on the Table 2.

	USD1	**USD2**	**USD6**
Deliverable>	Task 1	Task 2	Task 3
Weighting>	30%	20%	50%

Grade range	Apply skills of critical analysis to real world situations within a defined range of contexts	Demonstrate a high degree of professionalism* eg initiative, creativity, motivation, professional practice and self management.	Find, evaluate, synthesise and use information from a variety of sources
86%-100%	Novel and complex problems are evaluated thoroughly with reference to theory and practice, generating original solutions, expressed with clarity	There is evidence of the ability to work autonomously and creatively with reference to professional standards and values, reflecting critically on their own practice.	A complex and innovative project is designed, planned and carried out meticulously to gather and synthesise useful information from a wide range of appropriate primary and secondary sources to produce original outcomes of publishable standards
70%-85%	Novel and complex problems are evaluated with reference to theory and practice, generating original solutions	There is evidence of the ability to work autonomously and imaginatively with reference to professional standards and values, reflecting critically on their own practice.	A complex project is designed, planned and carried out thoroughly to gather useful information from a wide range of appropriate primary and secondary sources and synthesise the results to produce workable outcomes
60%-69%	Novel and complex problems are solved confidently with reference to theory and practice	There is evidence of the ability to work autonomously with reference to professional standards and values, reflecting critically on their own practice.	A project is carefully planned and carried out to gather useful information from appropriate primary and secondary sources and synthesise the results
50%-59%	Novel and complex problems are solved with reference to theory and practice	There is evidence of the ability to work with reference to professional standards and values, reflecting critically on their own practice.	A project is planned and carried out to gather information from appropriate primary and secondary sources and synthesise the results
45%-49%	Attempts to solve novel and complex problems are partial, with limited reference to theory and practice	There is evidence of a limited attempt to work as an autonomous professional who reflects on their own practice	Partial attempt to plan and/or carry out projects which gather information from appropriate primary and secondary sources
20%-44%	Attempts to solve novel and complex problems are inadequate, with little reference to theory and practice	There is limited evidence of any attempt to work as an autonomous professional who reflects on their own practice	Limited attempt to plan and/or carry out projects which gather information from appropriate primary and secondary sources

0%-19%	There is little or no evidence of any attempt to solve novel and complex problems with little or no reference to theory and practice	There is little or no evidence of working as an autonomous professional who reflects on their own practice	Little or no attempt to plan and/or carry out projects which gather information from appropriate primary and secondary sources

Table 2 – Grading range

Re-assessment

Note that opportunities to repeat assignments are not automatically provided, and when they are, the marks obtained may be capped. For more information about the regulations, please contact the Student Hub.

If you think you are at risk of failing this assignment, please seek advice as soon as possible form your Personal Tutor or the Support Tutors – with enough notice, there are many ways in which we can support you and help you to get back on track.

Appendix

Summary of AHEP-4 Learning Outcomes Evidenced:

M2	Formulate and analyse complex problems to reach substantiated conclusions. Applying PLC principles, students investigate the effect of different cycle times and reach optimised settings for the PWM Heater (Task 1).
M6	Apply an integrated or systems approach to the solution of complex problems. Applying control system principles, students provide solutions to simulate liquid tank flow dynamics (Task 3).
M12	Use practical laboratory and workshop skills to investigate complex problems. During completing Task 2 and Task 3, students use pre-prepared projects to further develop and enhance functionality of the automation systems.