

**BTEC**

# **HIGHER NATIONALS**

**Engineering**

**Higher National  
Certificate Lvl 4**

 **Pearson**

# Unit 15: Automation, Robotics and Programmable Logic Controllers (PLCs)

<b>Unit code</b>	<b>K/615/1489</b>
<b>Unit level</b>	<b>4</b>
<b>Credit value</b>	<b>15</b>

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## Introduction

The word automation was not used until the 1940s and it originated in the automotive manufacturing sector as a method designed to reduce labour costs and improve the quality, accuracy and precision of the finished products. We are all now very familiar with the sight of dancing robots, not only in the production of cars but in everything from washing machines to pharmaceuticals. As a result of this technology the products we purchase may have never been touched by human hands and we all benefit from a reduction in costs and improvement in quality.

The aim of this unit is for students to investigate how Programmable Logic Controllers (PLCs) and industrial robots can be programmed to successfully implement automated engineering solutions.

Among the topics included in this unit are: PLC system operational characteristics, different types of programming languages, types of robots and cell safety features.

On successful completion of this unit students will be able to program PLCs and robotic manipulators to achieve a set task, describe the types and uses of PLCs and robots available, write simple PLC programs, and program industrial robots with straightforward commands and safety factors.

## **Learning Outcomes**

By the end of this unit students will be able to:

1. Describe the design and operational characteristics of a PLC system.
2. Design a simple PLC program by considering PLC information, programming and communication techniques.
3. Describe the key elements of industrial robots and be able to program them with straightforward commands to perform a given task.
4. Investigate the design and safe operation of a robot within an industrial application.

## Essential Content

### LO1 Describe the design and operational characteristics of a PLC system

*System operational characteristics:*

Modular, unitary and rack mounted systems

Characteristics, including speed, memory, scan time, voltage and current limits

Input and output devices (digital, analogue)

Interface requirements

Communication standards (RS-232, RS-422, RS-485, Ethernet)

Internal architecture

Different types of programming languages (IEC 61131-3)

### LO2 Design a simple PLC program by considering PLC information, programming and communication techniques

*Programming language:*

Signal types

Number systems (binary, octal, hexadecimal)

Allocation lists of inputs and outputs

Communication techniques

Network methods

Logic functions (AND, OR, XOR)

Associated elements (timers, counters, latches)

*Test and debug methods:*

Systematic testing and debugging methods

Proper application of appropriate testing and debugging methods

**LO3 Describe the key elements of industrial robots and be able to program them with straightforward commands to perform a given task**

*Element considerations:*

Types of robots

Mobile robotics

Tools and end effectors

Programming methods

Robot manipulators (kinematics, design, dynamics and control, vision systems, user interfaces)

**LO4 Investigate the design and safe operation of a robot within an industrial application**

*Safety:*

Cell safety features

Operating envelope

Operational modes

User interfaces

## Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<b>L01</b> Describe the design and operational characteristics of a PLC system		<b>D1</b> Analyse the internal architecture of a typical PLC to determine its operational applications
<p><b>P1</b> Describe the key differences of PLC construction styles and their typical applications</p> <p><b>P2</b> Determine the types of PLC input and output devices available</p> <p><b>P3</b> Describe the different types of communication links used with PLCs</p>	<p><b>M1</b> Explain the different types of PLC programming languages available</p>	
<b>L02</b> Design a simple PLC program by considering PLC information, programming and communication techniques		<b>D2</b> Produce all elements of a PLC program for a given industrial task and analyse its performance
<p><b>P4</b> Design and describe the design elements that have to be considered in the preparation of a PLC programme program</p> <p><b>P5</b> Explain how communication connections are correctly used with the PLC</p>	<p><b>M2</b> Examine the methods used for testing and debugging the hardware and software</p>	

Pass	Merit	Distinction
<b>L03</b> Describe the key elements of industrial robots and be able to program them with straightforward commands to perform a given task		<b>D3</b> Design and produce a robot program for a given industrial task
<p><b>P6</b> Describe the types of industrial robots and their uses in industry</p> <p><b>P7</b> Describe the types of robot end effectors available and their applications</p>	<b>M3</b> Investigate a given industrial robotic system and make recommendations for improvement	
<b>L04</b> Investigate the design and safe operation of a robot within an industrial application		<b>D4</b> Design a safe working plan for an industrial robotic cell in a given production process to include a full risk assessment
<b>P8</b> Investigate the safety systems used within an industrial robotic cell	<b>M4</b> Analyse how the systems in place ensure safe operation of a given industrial robotic cell	

## Recommended Resources

### Textbooks

BOLTON, W. (2015) *Programmable Logic Controllers*. 5th Ed. Elsevier.

DAWKINS, N. (ed.) (2014) *Automation and Controls: A guide to Automation, Controls, PLCs and PLC Programming*.

PEREZ ANDROVER, E. (2012) *Introduction to PLCs: A beginner's guide to Programmable Logic Controllers*.

### Websites

<a href="http://www.plcmanual.com/">http://www.plcmanual.com/</a>	PLC Manual (General Reference)
<a href="http://www.plcs.net/">http://www.plcs.net/</a>	PLC Programming Info (General Reference)
<a href="http://www.learnaboutrobots.com/">http://www.learnaboutrobots.com/</a>	Learn About Robots Industrial Robots (General Reference)

### Links

This unit links to the following related units:

*Unit 6: Mechatronics*

*Unit 42: Further Programmable Logic Controllers (PLCs)*