Pearson BTEC | COMAU

Pearson BTEC
International Level 3 Specialist Award in

Robotic Operations

L3

Specification

First teaching from September 2020

Issue 2

Pearson BTEC International Level 3 Specialist Award in Robotic Operations

Specification

BTEC International Specialist and Professional qualifications
First registration May 2021

Issue 2

About Pearson

We are the world's leading learning company operating in countries all around the world. We provide content, assessment and digital services to schools, colleges and universities, as well as professional and vocational education to learners to help increase their skills and lifelong employability prospects. We believe that wherever learning flourishes so do people.

About Comau

Comau is a leading company in the industrial automation field, at a global level. Combining innovative engineering solutions with easy to use, open automation and enabling technologies, Comau helps companies of all sizes - and across a wide range of industrial segments - leverage the full potential of digital manufacturing. Comau's competency stems from over 45 years of field proven-experience and a strong presence within every major industrial country.

References to third-party material made in this specification are made in good faith. We do not endorse, approve or accept responsibility for the content of materials, which may be subject to change, or any opinions expressed therein. (Material may include textbooks, journals, magazines and other publications and websites.)

Publication code VQ000140

Welcome

With a track record built over 40 years of learner success, our BTEC qualifications are recognised by governments, industry and higher education.

What are BTEC International Specialist and Professional qualifications?

These BTEC qualifications are available at Levels 1–3 (Specialist) and at Levels 4–7 (Professional).

BTEC Specialist and Professional qualifications give learners the understanding and skills they need to prepare for employment in a sector or job role. They also provide career development opportunities for those already in work.

They put learning into the context of the world of work, giving learners the opportunity to apply their learning in relevant and realistic work contexts. This applied, practical approach means that learners develop the knowledge and skills they need for career progression or further study.

Sizes of qualification

Pearson estimates the number of guided learning hours (GLH) that will be needed for centre staff to deliver the qualification. This includes all training that involves centre staff in teaching and supervising learners, as well as all assessment activities.

BTEC Specialist and Professional qualifications are available in the following sizes:

- Award – a qualification with a GLH value of 10–120 hours
- Certificate – a qualification with a GLH value of 121–369 hours
- Diploma – a qualification with a GLH value of 370 or above.

Collaborative development

This qualification has been developed in joint working with Comau. We are grateful to all our colleagues in Comau that generously shared their time and expertise to help us develop these new qualifications.

Contents

Introduction to the Pearson BTEC International Level 3 Specialist Award in Robotic Operations

This specification contains all the information you need to deliver the Pearson BTEC International Level 3 Specialist Award in Robotic Operations.

This specification signposts the other essential documents and support that you need as a centre to deliver, assess and administer the qualifications, including the staff development required. A summary of all essential documents is given in *Section 7: Administrative arrangements*.

This qualification is not regulated in England.

The information in this specification is correct at the time of publication.

1 Qualification purpose and progression

Pearson BTEC International Level 3 Specialist Award in Robotic Operations

Who is this qualification for?

The Pearson BTEC International Level 3 Specialist Award in Robotic Operations is designed to provide focused and specialist vocational course in industrial automation with a clear work-related emphasis. The qualifications provide the knowledge, understanding and skills required to use robotic automation across a range of sectors.

The qualification develops a learner's abilities in robot programming and engineering, allowing the learner to understand the specific terms and techniques associated with working on a robotic system.

What could these qualifications lead to?

This qualification supports career progression. The Pearson BTEC International Level 3 Specialist Award in Robotic Operations can support learners intending to work in robotics and/or automation and seeking to expand their use of digital technologies.

2 Qualification summaries and key information

Qualification title	Pearson BTEC International Level 3 Specialist Award in Robotic Operations
Operational start date	03/05/2021
Entry requirements	This qualification is for learners aged 16 or above. There are no specific entry requirements; however, centres must ensure that learners have sufficient capacity and/or experiential learning to undertake this Level 3 qualification. Please also refer to *Section 7: Administrative Arrangements*.
Guided Learning Hours (GLH)	55
Total Qualification Time	85 hours
Assessment	The units are assessed using assignments that are set and marked by the centre.
Unit grading information	Pass
Qualification grading information	Pass

3 Structure

Pearson BTEC International Level 3 Specialist Award in Robotic Operations

Learners will need to meet the requirements outlined in the table below before the qualification can be awarded.

Pearson BTEC International Level 3 Specialist Award in Robotic Operations		
Unit number	**Unit title**	**GLH**
Learners must achieve all Units		
1	Robotics Systems and Basic Procedures	**10**
2	Fieldbus and Reference Systems	**10**
3	Motion Programming	**15**
4	Further Robot Programming	**20**

4 Units

Understanding your units

The units in this specification set out our expectations of assessment in a way that helps you to prepare your learners for assessment. The units help you to undertake assessment and quality assurance effectively.

Each unit in the specification is set out in a similar way. This section explains how the units work. It is important that all teachers, assessors, internal verifiers and other staff responsible for the programme review this section.

Section	Explanation
Unit number	The number is in a sequence in the specification. Where a specification has more than one qualification, numbers may not be sequential for all qualifications.
Unit title	This is the formal title that we always use, and it will appear on learners' certificates.
Level	All units and qualifications have a level assigned to them. The levels correspond with the levels used in the UK's Regulated Qualification Framework.
Unit type	This says whether the unit is mandatory or optional for the qualification.
Guided Learning Hours (GLH)	Guided Learning Hours (GLH) is an estimate of the number of hours that will be needed for a typical learner to achieve the unit. Guided learning includes all training that involves centre staff in teaching and supervising learners, as well as all assessment activities.
Unit introduction	This summarises the content of the unit and how learners will benefit from taking it.
Learning outcomes and assessment criteria	The learning outcomes set out what a learner must know, understand or be able to do as the result of a process of learning. The assessment criteria specify the standard the learner is required to meet to achieve a learning outcome.
Unit content	This section sets out what needs to be taught. Content is compulsory except when it follows an 'e.g.'.
Essential information for assessors	This section gives information to support delivery and implementation of assessment.
Suggested assessment approach	This gives suggestions for how to assess the learning outcomes.
Assessment requirements	This gives detailed information about what evidence learners need to show in order to meet the assessment requirements.

Index of units

This section contains all the units developed for these qualifications. Please refer to *page 4* to check which units are available.

Unit 1: Robotics Systems and Basic Procedures

Level: 3

Unit type: Mandatory

Guided learning hours: 10

Unit introduction

Robotic automation is at the forefront of the latest industry developments across a range of engineering sectors. Industrial robots are used within heavy production environments such as motor car assembly, as well as in light industry such as printed circuit board (pcb) assembly. Robots are also being introduced into ancillary operations such as product picking, packing, test and inspection.
This unit develops a learner's abilities in robot programming and engineering, allowing the learner to understand the specific terms and techniques associated with working on a robotic system. This in turn will prepare them for a trainee or apprentice role in this field, or for further study in this subject area.

Learning outcomes and assessment criteria

To pass this unit, the learner needs to meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria	
A	Understand the main components of the robotic system and their function	A.1	Explain how and why the main components of the ARM function correctly
		A.2	Explain how and why the main components of the control unit function correctly
B	Be able to use the teach pendant (programming terminal)	B.1	Explain the main teach pendant commands and functions
		B.2	Correctly use the graphical user interface to safely move the ARM to a given specification
C	Safely use the correct operating procedures of a robot control unit	C.1	Discuss the need for degrees of protection in a robotic system in relation to given IP ratings
		C.2	Correctly and safely use the control unit to meet given objectives

Unit content

Learning outcome A: Understand the main components of the robotic system and their function

- The main components of the robotic ARM and their functions:
  - motors
  - gearboxes
  - mechanical structure
  - basic wiring.
- The main components of the control unit and their functions:
  - operator panel
  - power modules
  - CPU
  - battery
  - connections panel
  - power supplies
  - safety boards
  - electromechanical parts.

Learning outcome B: Be able to use the teach pendant (programming terminal)

- Operating modes of the teach pendant (program mode, local mode, remote mode).
- Teach pendant layout:
  - mode selector
  - emergency stop
  - enabling device
  - membrane keyboard – colours of keys and their functions.
- Moving the ARM using the teach pendant:
  - manual movement using JOG buttons.
- Basic procedures to use the graphical user interface (GUI).
- Page descriptions:
  - menu page
  - home page
  - motion page
  - alarm page
  - prog page
  - other pages.
- Always-visible elements:
  - message bar
  - right menu
  - status bar.

Learning outcome C: Safely use the correct operating procedures of a robot control unit

- Degrees of protection.
- Need for protection.
- Ingress protection (IP) ratings.
- Control unit physical procedures (powering up, shutting down, restarting):
    - turning on
    - restart
    - drive on/drive off
    - log in with PU user
    - creation of a new user with different privileges
    - turning off.

Essential information for assessors

Essential resources

Please see *Section 8: Quality assurance* for details of resources needed to deliver all units.

Suggested assessment approach

This section must be read in conjunction with *Section 6: Assessment*.

This unit is assessed internally by the centre and externally verified by Pearson.

The table below shows the suggested approach to assessments.

When preparing the assessment for this unit, the learner should be given an assignment brief designed by the tutor. This brief should be set in a specific organisational context. It should draw on learning from the unit and be designed in a way that enables learners to meet all the assessment criteria.

Learning outcome	Suggested assessment approach
A Understand the main components of the robotic system and their function	A two-page statement or five-slide presentation reporting on the main components of a robotic system and the control unit.
B Be able to use the teach pendant (programming terminal)	A demonstration of how to use the programming terminal to move the ARM for a given engineering scenario, using specific commands and functions. This could include a quiz or question-and-answer session.
C Safely use the correct operating procedures of a robot control unit	A verbal or written discussion around degrees of protection and the IP rating system. Demonstration of safe and correct use of the control unit.

Assessment requirements

Learning outcome A

Learners would be expected to provide information on the main components of the robot ARM and the control unit, as listed in the unit content. Learners must reference how and why the different parts of the robotic system function correctly.

Learning outcome B

Learners need to demonstrate the skills necessary to use the different teach pendant operating modes. They must explain how keys on the pendant can be used to achieve given commands and functions. This can be assessed using actual equipment or through the use of good quality diagrams. Learners must cover operating mode, emergency stop, device enabling, navigation keys (blue keys), ARM motion keys (black keys).

Learners must physically operate the robot ARM using the GUI of the teach pendant. This will be a simple movement which uses the menu system of the GUI to achieve the task.

Learning outcome C

Learners must demonstrate their understanding of the IP rating system for protection equipment. This could be assessed by giving learners at least three different scenarios in which equipment requires protection against certain environmental factors and learners select and justify an appropriate IP level in each case. A minimum of four different IP ratings must be covered, learners must cover from IP0x to IP6x, with two of the scenarios showing the difference between IP6x levels (eg IP64 and IP66).

Learners must demonstrate how to safely use the control unit, both physically (power up, shutdown, restart) and using the GUI (login, create new user, set privileges).

Unit 2: Fieldbus and Reference Systems

Level: 3

Unit type: Mandatory

Guided learning hours: 10

Unit introduction

Robotics and automated systems are utilised in a wide range of industries for many different operations. For these operations, organisations need suitably qualified engineers and experts in robotics to ensure their systems are designed and operated with the greatest accuracy and efficiency.

In this unit learners will examine the possible integrations of robotised systems in fieldbus networks. They will consider the various types of inputs and outputs within a system, and recognise the differences between them. Learners will coordinate reference systems, specifically 3D reference systems. They will distinguish between local and remote systems and perform tool calculations using different methods and procedures. The final part of the unit will see learners investigating the importance of declaring correct payloads, and performing calibration checks, payload and Uframe calculations. This unit will help learners prepare for a robotics and engineering traineeship/apprenticeship, as well as helping them gain employment as a robotics technician. Alternatively, learners can choose to continue their studies in higher education.

Learning outcomes and assessment criteria

To pass this unit, the learner needs to meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria	
A	Understand robotised systems, their key inputs and outputs	A.1	Explain possible integrations of the robotised system in a fieldbus network
		A.2	Describe types of inputs and outputs and the differences between these
B	Use 3D reference systems to meet given objectives	B.1	Coordinate reference systems by identifying 3D reference systems
		B.2	Distinguish the characteristics of local and remote systems
		B.3	Perform tool calculations using different procedures and methods
C	Use robotics calculations to confirm use of robotics software and equipment	C.1	Explain the importance of declaring the correct payload
		C.2	Describe the calibration position check procedure
		C.3	Use and check calculations using appropriate software

Unit content

Learning outcome A: Understand robotised systems, their key inputs and outputs

- Fieldbus and distributed control systems, including:
  - for manufacturing automation distributed control systems, features to support fast reaction times and short transmission length and data size
    - MODBUS
    - PROFIBUS
    - INTERBUS
    - CAN.
  - for process automation distributed control systems, features to support data over hundreds of metres and their safety reputation in hazardous areas
    - PROFIBUS-PA
    - Foundation Fieldbus.
  - for building automation distributed control systems and their features of simple inputs and outputs over a large area and management network abilities, with commonly used fieldbuses BACnet and LonWorks.
- The definition of common inputs and outputs in distributed control systems and the differences between them:
  - digital inputs and outputs, using single-bit Boolean values, using $DIN ports and input signals from digital sensors, and $DOUT ports and outputs e.g. LEDs, solenoids and lamps
  - analog inputs and outputs, using groups of bits interpreted as 16-bit integers, using $AIN ports from analog sensors, and $AOUT ports to current and voltage controllers
  - flexible inputs and outputs, using groups of bits interpreted as between 1 and 32 bits, using signals from $FMI and $FMO ports to exchange information between devices such as from a PLC to ARM.

Learning outcome B: Use 3D reference systems to meet given objectives

- Use of Cartesian coordinates and distinctive types of 3D reference systems, including:
  - base coordinate system, World, and reference to the 'right-hand rule'
  - user frames or work objects, and how they relate to the base system
  - tool coordinate system, including the tool center point (TCP).
- Local and remote systems, including:
  - local systems, where the tool is mounted on the flange and the tool is located outside the ARM, and characteristics such as location, speed of interaction, resource required and proximity to equipment
  - remote systems, where the tool is mounted outside the ARM and mounted on the flange, and characteristics such as control from the master control room (MCR) or production control room (PCR), proximity to the equipment, and resource required.

- Position variables of a reference system, including:
    - joint position defining the values in degrees or millimetres of the ARM axes, and use to define the offset position and the cell
    - defining the position of the TCP in relation to the Uframe, and the effect they have on the positioning of the ARM
    - extended position and its ability to provide information about additional auxiliary axes.
- Tool setup calculations to calculate the TCP using the methods:
    - standard – measuring the tool and calculation of tool center point of an unknown tool to a known tool
    - four-point method – jogging about the tool center point to points P1 to P4.

Learning outcome C: Use robotics calculations to confirm use of robotics software and equipment

- Payload calculation:
    - importance of declaring the correct payload, including safety, acceleration as well as aspects such as grip force, weight and reach
    - calibration position check procedure, including base calibration, tool calibration, robot calibration and validation steps
    - payload calculation using automatic payload identification software using the IDENT and ARMLOAD functions.
- Uframe calculation using the automatic Uframe calculation feature in software, following a defined procedure, including:
    - taking the TCP on the desired plane, including points to describe the plane's origin, the X-axis and the plane's orientation.

Essential information for assessors

Essential resources

Please see *Section 8: Quality assurance* for details of resources needed to deliver all units.

Suggested assessment approach

This section must be read in conjunction with *Section 6: Assessment*.

This unit is assessed internally by the centre and externally verified by Pearson.

The table below shows the suggested approach to assessments.

When preparing the assessment for this unit, the learner should be given an assignment brief designed by the tutor. This brief should be set in a specific organisational context. It should draw on learning from the unit and be designed in a way that enables learners to meet all the assessment criteria.

Learning outcome	Suggested assessment approach
A Understand robotised systems, their key inputs and outputs	A report focusing on the possible integrations of different robotised systems in fieldbus networks and the differences between the probable inputs and outputs in these systems.
B Use 3D reference systems to meet given objectives	A logbook identifying use of different 3D reference systems, a record of the procedures and methods carried out, supported by observation records and outputs of calculations.
C Use robotics calculations to confirm use of robotics software and equipment	A portfolio of evidence, including observation records/witness statements, procedural documents to perform calibration checks, and payload calculations using software and automatic Uframe calculations.

Assessment requirements

Learning outcome A

For at least two industrial examples of distributed control systems, learners must identify components and provide information on the appropriate selection of fieldbus systems suitable to each. Learners must provide information on the types of input and output signals that could be employed within, and how these differ between each distributed control system. The control systems must be no more than three hierarchical layers and incorporate no more than 8 elements. At least one system must be robotic in nature. Technical data necessary to specify a suitable type, such as industry sector, system complexity/size, component manufacturer etc would be appropriate. Specific technical data on Fieldbus systems is not required.

Learning outcome B

Learners need to undertake a series of practical activities that demonstrate identification of 3D reference systems (WORLD frame, BASE frame, TOOL frame, UFRAME frame), including differences between local and remote systems and performance of Tool calculations using a range of different methods and procedures.

Learning outcome C

Learners need to provide information on the entry of payloads into the robotic system, including the use of the 'automatic payload identification' facility. They need to highlight the consequences of incorrect or missing payload declaration.

Learners must demonstrate use of the necessary procedures to perform Uframe calculations and results obtained. They need to check their TOOL and Uframe calculations by carrying out the relevant check procedures.

Unit 3: Motion Programming

Level: 3

Unit type: Mandatory

Guided learning hours: 15

Unit introduction

Robotic automation is at the forefront of the latest industry developments across a range of engineering sectors. Industrial robots are used within heavy production environments such as motor car assembly, as well as in light industry such as pcb assembly. Robots are also being introduced into ancillary operations such as picking, packing, test and inspection.

This unit prepares learners for the role of robot programming engineer. It will enable them to understand the specific terms and techniques associated with moving the robot tool in free space. This in turn will prepare them for a trainee or apprentice role in this field, or for further study in this subject area.

Learning outcomes and assessment criteria

To pass this unit, the learner needs to meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria	
A	Understand the initial requirements for creating a robot program	A.1	Describe creation and activation of movement programming
		A.2	Analyse differences between JOINT and LINEAR trajectories
		A.3	Create robot movement programming for a given scenario
B	Develop robot programming using system variables	B.1	Modify an existing robot program to allow continuous movement
		B.2	Create movement programming containing a circular trajectory
C	Demonstrate how to create structured programs	C.1	Create an automatically executing MAIN program with subprograms
		C.2	Evaluate the use of ROUTINES and COLLISION DETECTION in a movement program

Unit content

Learning outcome A: Understand the initial requirements for creating a robot program

- Parts of the program:
  - introducing the PDL2 language, creating a program and describing its constituent elements
  - activating Tool and Uframe
  - describing the operations to perform to record a position within a movement program.
- Recognising and assessing the appropriate trajectories for a movement command:
  - JOINT
  - LINEAR.
- Creating a robot program:
  - creating a new program
  - checking positions
  - editing positions
  - completing the program
  - saving the program.

Learning outcome B: Develop robot programming using system variables

- System variable concepts and types:
  - introducing the concept of system variables, describing the speed variables and their effects
  - termination variables
  - entering variables in a program
  - introducing the $TERM_TYPE variable and exploring its effects
  - describing how to use the various variables within a program.
- Continuous movement:
  - introducing the concept of continuous movement using the MOVEFLY TO command and the $FLY_PER variable
  - entering variables in a program, continuous movement and variable used to manage a continuous movement.
- Circular trajectories:
  - the CIRCULAR trajectory – creation of the circle program and checks
  - the orientation variable
  - steps that can be used to program a circle movement and check the program
  - being able to create a movement program containing circular trajectories.

Learning outcome C: Demonstrate how to create structured programs

- The 'MAIN' program:
  - understanding the meaning of the MAIN program and how it works
  - describing the main commands that can be used in the PDL2 language
  - creating a MAIN program using the programming terminal.
- Routines and collision detection:
  - understanding how ROUTINES are useful when structuring a program
  - understanding the need for collision detection.

Essential information for assessors

Essential resources

Please see *Section 8: Quality assurance* for details of resources needed to deliver all units.

Suggested assessment approach

This section must be read in conjunction with *Section 6: Assessment*.

This unit is assessed internally by the centre and externally verified by Pearson.

The table below shows the suggested approach to assessments.

When preparing the assessment for this unit, the learner should be given an assignment brief designed by the tutor. This brief should be set in a specific organisational context. It should draw on learning from the unit and be designed in a way that enables learners to meet all the assessment criteria.

Learning outcome	Suggested assessment approach
A Understand the initial requirements for creating a robot program	A report, with diagrams, on the component parts of a robot program. Case study on the suitability of trajectories for given automated operations. Creation of a robot program to a given scenario.
B Develop robot programming using system variables	Modification of an existing program to add continuous movement. Creation of a new program to produce a circular trajectory.
C Demonstrate how to create structured programs	Creation of a correctly structured program. Verbal evidence or audio-visual recording of discussion on the use of routines and collision detection.

Assessment requirements

This unit should be assessed through the use of practical exercises using a robotised system. Evidence could be generated through one or more of the following methods:

- logbook of procedures undertaken and results obtained
- observation of the programming procedure and outcomes
- photographic/audio-visual evidence of the robot program and/or final robot motion.

Learning outcome A

Learners must provide information on the required constituent parts of a motion program. At least two different robotic automation scenarios could be given to learners to identify, with justification, whether JOINT or LINEAR trajectories would be most appropriate on each occasion. This should be assessed as learners work on creating robot programs.

Learning outcome B

Learners could modify a robot program they developed for learning outcome A or be given one to work with. They need to create a circular trajectory within a program.

Learning outcome C

Learners need to create a correctly structured program using the MAIN program and subroutines. They need to provide information on the comparative use of routines and collision detection, either during their own programming activities or through the use of given programs.

Unit 4: Further Robot Programming

Level: 3

Unit type: Mandatory

Guided learning hours: 20

Unit introduction

Robotic automation is at the forefront of the latest industry developments across a range of engineering sectors. This unit builds on the programming techniques from *Unit 3: Motion Programming*, focusing on the non-routine procedures which learners can use to enhance their programming ability. Learners will learn the system procedures, allowing them to access system memory, backup and restore programs.
There is an introduction to the optional WinC5G software, which can be used for more advanced robot programming, and also an outcome which focuses on efficiency and speed of programming and operation.
The unit concludes with an opportunity for learners to demonstrate the knowledge, understanding and skills they have gained across all four units of the qualification.

Learning outcomes and assessment criteria

To pass this unit, the learner needs to meet all the learning outcomes for the unit. The assessment criteria determine the standard required to achieve the unit.

Learning outcomes		Assessment criteria	
A	Understand system procedures used in robot programming	A.1	Explain the system memory layout
		A.2	Back up and restore a program
B	Investigate the use of WinC5G software	B.1	Compare the use of the WinC5G software with manual programming when creating robot programs
		B.2	Use the WinC5G software to perform a non-routine procedure
C	Demonstrate how to create efficient programs	C.1	Use techniques to create efficiency in given programs
		C.2	Evaluate a robot program in terms of improving efficiency
D	Use planning and integration skills to produce automated solutions	D.1	Plan automation for a given process
		D.2	Develop robot programming to automate a given process

Unit content

Learning outcome A: Understand system procedures used in robot programming

- Structure of the system memory:
  - execution memory
  - storage memory
  - external memory.
- Components of the system memory and analysing structure and operation:
  - program files
  - system configuration files.
- Backup and restore non-routine procedures:
  - backup procedure:
    - manual setting
    - pre-configured setting
  - restore procedure:
    - manual setting
    - pre-configured setting
  - reload procedure.
- Other non-routine procedures:
  - turn set procedure
  - calibration procedure.

Learning outcome B: Investigate the use of WinC5G software

- Software overview:
  - the WinC5G program
  - connecting with WinC5G
  - comparison with manual programming when programming robots
  - software options:
    - Cooperative Motion
    - Joint Soft Servo
    - Sensor Tracking
    - Palletizing Motion
    - Synchronized Arms
    - Weaving Motion
    - Interference Region
    - Conveyor Tracking.
- Performing non-routine procedures through WinC5G:
  - turn set procedure
  - calibration procedure.

Learning outcome C: Demonstrate how to create efficient programs

- Identifying and implementing efficiency improvements:
  - looking for repeated operations, or set of operations
  - using the QUICK command.
- Programming tips:
  - using CAUSE and REMEDY to debug programs
  - using 'Favourites' to speed up navigation
  - using incremental jog to easily position the TCP.

Learning outcome D: Use planning and integration skills to produce automated solutions

- Plan an automation solution:
  - opportunities for automating part/all of the process analysis
  - suitable robot system selection
  - suitable end effector(s) selection
  - project timescale
  - safety requirements for the automated system.
- Implement an automation solution:
  - robot program to meet the requirements of the process
  - program testing and debugging
  - program backup
  - efficiency savings opportunities.

Essential information for assessors

Essential resources

Please see *Section 8: Quality assurance* for details of resources needed to deliver all units.

Suggested assessment approach

This section must be read in conjunction with *Section 6: Assessment*.

This unit is assessed internally by the centre and externally verified by Pearson.

The table below shows the suggested approach to assessments.

When preparing the assessment for this unit, the learner should be given an assignment brief designed by the tutor. This brief should be set in a specific organisational context. It should draw on learning from the unit and be designed in a way that enables learners to meet all the assessment criteria.

Learning outcome	Suggested assessment approach
A Understand system procedures used in robot programming	Report on the structure of the system memory. Flowchart or similar diagram explaining the non-routine procedures. Demonstration of how to perform a simple non-routine procedure.
B Investigate the use of WinC5G software	Practical demonstration of use of the WinC5G software.
C Demonstrate how to create efficient programs	Practical evidence of improving efficiency within a pre-written program, a rewritten program.
D Use planning and integration skills to produce automated solutions	Creation of a project plan covering resources and timescales. Implementation of a robot program.

Assessment requirements

Learning outcome A

Learners need to provide information on how the structure and components of the system memory function and how to back up and restore a program.

Learning outcome B

Learners need to demonstrate their use of WinC5G software to perform a non-routine procedure such as turn set or calibration and provide information on how this compares to older manual programming processes, with the pros and cons of each method.

Learning outcome C

Learners need to improve a given robot program in order to increase its efficiency. This could be a program provided by the tutor or one created by the learners themselves.

Learning outcome D

This learning outcome provides the opportunity for learners to demonstrate the knowledge and skills acquired across the qualification to produce a robotic automated solution to a given scenario.

Tutors should generate suitable scenarios for learners to produce, from scratch, a robot program to fulfil the required specification. Learners need to plan their approach to the project. This may require the selection of a suitable hardware such as robot type, end effector, control unit with suitable IP protection, or distributed communications. It is understood that centre resources may not allow access to different hardware configurations to meet this requirement. In this case, learners can outline the ideal solution and then consider how they will achieve this with the resources available. During planning they will also need to consider timescales. Learners will now know about the requirements when creating structured programs, performing the required calibration and calculations, creating their programs, testing and debugging, etc., so can factor these into their timing plan.

In order to replicate real-life automation projects, evidence should be a formal project plan, which should be presented to the customer (i.e. assessor) and agreed before the project can continue.

5 Programme delivery

Centres can deliver this qualification in license to, and with the use of, Comau software and materials. Centres are free to offer these qualifications using any mode of delivery that meets learners' needs. This might include full-time or part-time direct instruction in classrooms, distance learning and independent study.

Centres must make sure that learners have access to the identified resources and to the subject specialists delivering the units.

Those planning the programme should aim to enhance the vocational nature of the qualifications by:

- developing up-to-date and relevant teaching materials that make use of scenarios or case studies that are relevant to the sector
- giving learners the opportunity to apply their learning in realistic practical activities, for example creating business documentation or performing role plays
- developing projects with input from employers.

Where legal requirements are taught, centres must ensure that legislation/laws are up to date.

Digital Course

Comprehensive digital learning content for this qualification is available from Comau at webacademy.comau.com.

6 Assessment

To achieve a pass for these qualifications, the learner must achieve all the units required in the qualification structures.

Internal assessment

All units in these qualifications are internally assessed. This means that centres set and mark the assessments, which are then subject to external standards verification by a Pearson standards verifier.

Assessment using assignments

For all units, the format of assessment is an assignment taken after the content of the unit has been delivered. An assignment may take a variety of forms, including practical and written. Assignments are separate from teaching, practice and other activities that learners complete with input from teachers. Assignments must be completed independently by learners, which means they work on their own without input from other learners or teachers.

An assignment needs to be issued to learners as an assignment brief that includes a start date, a completion date and clear requirements for the evidence that they need to provide. Assignments should be set within a specific organisational context. Assignments can be divided into tasks and may require several forms of evidence, including written tasks and observations.

Teachers will set the assignments. These must allow learners to generate the evidence required to meet the assessment criteria and the *Essential information for assessors* for the unit.

Issuing assessment decisions and feedback

Once the assessor has completed the assessment process for an assignment, the outcome is a formal assessment decision. This is recorded formally and reported to learners.

The information given to the learner:

- must show the formal decision and how it has been reached, indicating how or where criteria have been met
- may show why achievement of assessment criteria has not been demonstrated
- must not provide feedback on how to improve evidence
- must be validated by an internal verifier before it is given to the learner.

Resubmissions and retakes

Learners who do not successfully pass an assignment are allowed one opportunity to resubmit evidence for this assignment. If they still do not reach the required standard, they should be given one opportunity to retake a different assignment that covers the same learning outcome(s).

7 Administrative arrangements

Introduction

This section focuses on the administrative requirements for delivering a BTEC qualification. It is of particular value to Quality Nominees, Lead IVs and Programme Leaders.

Learner registration and entry

Shortly after learners start the programme of learning, you need to make sure that they are registered for the qualification. You need to refer to the relevant section for BTEC International in the Information Manual for information on making registrations for the qualification.

Learners can be formally assessed only for a qualification on which they are registered. If learners' intended qualifications change, for example if a learner decides to choose a different pathway specialism, then the centre must transfer the learner appropriately.

Centres will need to review the entry profile for qualifications and/or experience held by applicants, considering whether this profile shows ability to progress to a Level 3 qualification. A typical entry profile would consist of Level 2 or Level 3 qualifications or work experience in an engineering/robotics environment, along with demonstration of numeracy skills and oral and written competence in the English language.

Access to assessment

Assessments need to be administered carefully to ensure that all learners are treated fairly, and that results and certification are issued on time to allow learners to progress to their chosen progression opportunities.

Pearson's *Equality Policy* requires that all learners should have equal opportunity to access our qualifications and assessments, and that our qualifications are awarded in a way that is fair to every learner. We are committed to making sure that:

- learners with a protected characteristic are not, when they are undertaking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Further information on access arrangements can be found in the document *Supplementary guidance for reasonable adjustments and special consideration*.

Administrative arrangements for assessment

Records

You are required to retain records of assessment for each learner. Records should include decisions reached and any adjustments or appeals. Further information can be found in the relevant section of the *BTEC International in the Information Manual*. We may ask to audit your records, so they must be retained as specified.

Reasonable adjustments to assessment

To ensure that learners have fair access to demonstrate the requirements of the assessments, a reasonable adjustment is one that is made before a learner is assessed. You are able to make adjustments to internal assessments to take account of the needs of individual learners. In most cases, this can be achieved through allowing the use of assistive technology or adjusting the format of evidence. Any reasonable adjustment must reflect the normal learning or working practice of a learner in a centre or working within the occupational area. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. You need to plan for time to make adjustments if necessary.

Further details on how to make adjustments for learners with protected characteristics are given on our website, in the document *Supplementary guidance for reasonable adjustments and special consideration*.

Appeals against assessment

Your centre must have a policy for dealing with appeals from learners. These appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy could be a consideration of the evidence by a Lead IV or other member of the programme team. The assessment plan should allow time for potential appeals after assessment decisions have been given to learners. If there is an appeal by a learner, you must document the appeal and its resolution. Learners have a final right of appeal to Pearson but only if the procedures that you have put in place have not been followed. Further details are given in the document *Internal assessment in vocational qualifications: reviews and appeals policy*.

Dealing with malpractice in assessment

Malpractice means acts that undermine the integrity and validity of assessment, the certification of qualifications and/or may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actual or attempted actions of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where malpractice or attempted malpractice has been proven.

Malpractice may occur or be suspected in relation to any unit or type of assessment within a qualification. For further details on malpractice and advice on preventing

malpractice by learners, please see Pearson's *Centre guidance: Dealing with malpractice and maladministration*, available on our website.

The procedures we ask you to adopt vary between units that are internally assessed and those that are externally assessed.

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The *Centre Guidance: Dealing with Malpractice* document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe a centre is failing to conduct internal assessment according to our policies. The above document gives further information and examples, and details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Learner malpractice

The head of centre is required to report incidents of suspected learner malpractice that occur during Pearson qualifications. We ask centres to complete JCQ Form M1 (www.jcq.org.uk/malpractice) and email it with any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Processing team at candidatemalpractice@pearson.com. The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Teacher/centre malpractice

The head of centre is required to inform Pearson's Investigations team of any incident of suspected malpractice (which includes maladministration) by centre staff, before any investigation is undertaken. The head of centre is requested to inform the Investigations team by submitting a JCQ M2 Form (downloadable from www.jcq.org.uk/malpractice) with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff, anonymous informants), the Investigations team will conduct the investigation directly or may ask the head of centre to assist.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results/certificates while an investigation is in progress. Depending on the outcome of the investigation, results and/or certificates may not be released or they may be withheld.

We reserve the right to withhold certification when undertaking investigations, audits and quality assurance processes. You will be notified within a reasonable period of time if this occurs.

Sanctions and appeals

Where malpractice is proven, we may impose sanctions or penalties, such as:

- mark reductions for affected external assessments
- disqualification from the qualification
- debarment from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures, we may impose sanctions such as:

- working with centres to create an improvement action plan
- requiring staff members to receive further training
- placing temporary blocks on the centre's certificates
- placing temporary blocks on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for centres that are considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from the head of centre (on behalf of learners and/or members or staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in the JCQ Appeals booklet (https://www.jcq.org.uk/exams-office/appeals).

Certification and results

Once a learner has completed all the required components for a qualification, the centre can claim certification for the learner, provided that quality assurance has been successfully completed. For the relevant procedures, please refer to our *Information Manual*/*International Information Manual*.

Additional documents to support centre administration

As an approved centre, you must ensure that all staff delivering, assessing and administering the qualifications have access to the following documentation. These documents are reviewed annually and are reissued if updates are required.

- *Pearson International Quality Assurance Handbook*: this sets out how we will carry out quality assurance of standards and how you need to work with us to achieve successful outcomes.
- *Information Manual*/*International Information Manual*: this gives procedures for registering learners for qualifications, transferring registrations and claiming certificates.
- *Regulatory policies*: our regulatory policies are integral to our approach and explain how we meet internal and regulatory requirements. We review the regulated policies annually to ensure that they remain fit for purpose. Policies related to this qualification include:
    - adjustments for candidates with disabilities and learning difficulties, access arrangements and reasonable adjustments for general and vocational qualifications
    - age of learners
    - centre guidance for dealing with malpractice
    - recognition of prior learning.

This list is not exhaustive and a full list of our regulatory policies can be found on our website.

8 Quality assurance

Centre and qualification approval

As part of the approval process, your centre must make sure that the resource requirements listed below are in place before offering the qualifications.

- Centres must have access to appropriate physical resources (for example equipment, IT, learning materials, multimedia teaching rooms) to support the delivery and assessment of the qualification:
    - For both teachers and learners, access to robotics software, or alternatively, a robotised system present at the centre.
    - Teacher access to multimedia station with internet access (including Microsoft Windows 7 or above and virtualisation functions enabled by BIOS) and projector and/or interactive whiteboard facilities.
    - Learner access to multimedia stations with internet access (including Microsoft Windows 7 or above and virtualisation functions enabled by BIOS), ideally a station for each learner. Comau offer videos that are provided with English subtitles.
- Staff involved in the assessment process must have relevant expertise and/or occupational experience.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Centres must have in place appropriate health and safety policies relating to the use of equipment by learners.
- Centres must deliver the qualification in accordance with current equality and diversity legislation and/or regulations.

Continuing quality assurance and standards verification

On an annual basis, we produce the *Pearson International Quality Assurance Handbook*. It contains detailed guidance on the quality processes required to underpin robust assessment and internal verification.

The key principles of quality assurance are that:

- a centre delivering BTEC programmes must be an approved centre, and must have approval for the programmes or groups of programmes that it is delivering
- the centre agrees, as part of gaining approval, to abide by specific terms and conditions around the effective delivery and quality assurance of assessment; the centre must abide by these conditions throughout the period of delivery
- an approved centre must follow agreed protocols for standardisation of assessors and verifiers, for the planning, monitoring and recording of assessment processes, and for dealing with special circumstances, appeals and malpractice.

The approach of quality-assured assessment is through a partnership between an approved centre and Pearson. We will make sure that each centre follows best practice and employs appropriate technology to support quality-assurance processes, where practicable. We work to support centres and seek to make sure that our quality-assurance processes do not place undue bureaucratic processes on centres. We monitor and support centres in the effective operation of assessment and quality assurance.

The methods we use to do this include:

- making sure that all centres complete appropriate declarations at the time of approval
- undertaking approval visits to centres
- making sure that centres have effective teams of assessors and verifiers who are trained to undertake assessment
- assessment sampling and verification, through requested samples of assessments and associated documentation
- an overarching review and assessment of a centre's strategy for delivering and quality assuring its BTEC programmes.

Centres that do not fully address and maintain rigorous approaches to delivering, assessing and quality assurance cannot seek certification for individual programmes or for all BTEC programmes. An approved centre must make certification claims only when authorised by us and strictly in accordance with requirements for reporting.

Centres that do not comply with remedial action plans may have their approval to deliver qualifications removed.

For information about Pearson Qualifications, including Pearson Edexcel and BTEC qualifications visit qualifications.pearson.com

Pearson Education Limited. Registered in England and Wales No. 872828
Registered Office: 80 Strand, London WC2R 0RL.

VAT Reg No GB 278 537121

Pearson
BTEC

Publication code:
VQ000140