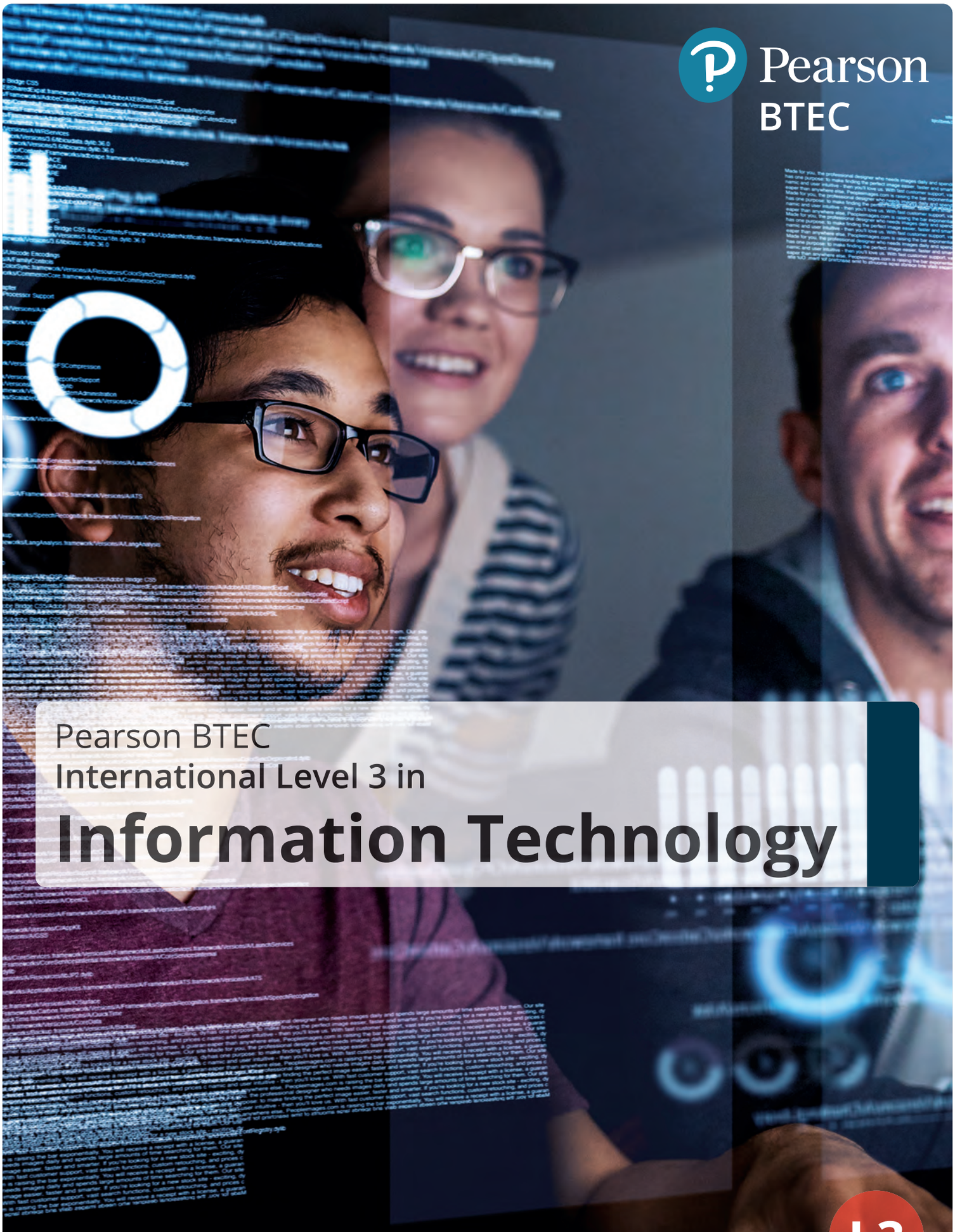

Pearson BTEC

International Level 3 in Information Technology

L3

Specification

First teaching from April 2020

Issue 3

Pearson BTEC

Pearson BTEC International Level 3 Qualifications in Information Technology

Specification

First teaching April 2020

Issue 3

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 learners, educational institutions, employers, governments and other partners globally. We are committed to helping equip learners with the skills they need to enhance their employability prospects and to succeed in the changing world of work. We believe that wherever learning flourishes so do people.

This specification is Issue 3. We will inform centres of any changes to this issue.
The latest issue can be found on our website.

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

ISBN 978 1 446 96092 9

Welcome

With a track record built over 40 years of learner success, our BTEC International Level 3 qualifications are recognised internationally by governments, industry and higher education. BTEC International Level 3 qualifications allow learners to progress to the workplace – either directly or via study at a higher level. Over 100,000 BTEC learners apply to university every year. Their Level 3 BTECs, either on their own or in combination with A Levels, are accepted by UK and international universities, and higher-education institutes for entry to relevant degree programmes.

Career-ready education

BTECs enable a learner-centred approach to education, with a flexible, unit-based structure and knowledge applied to project-based assessments. BTECs focus on the holistic development of the practical, interpersonal and thinking skills required to be successful in employment and higher education.

When creating the BTEC International Level 3 qualifications in this suite, we worked with many employers, higher-education providers, colleges and schools to ensure that we met their needs. Employers are looking for recruits who have a thorough grounding in the latest industry requirements and work-ready skills, for example teamwork. Learners who progress to higher education need experience of research, extended writing and meeting deadlines. BTEC qualifications provide the breadth and depth of learning to give learners this experience.

BTEC addresses these needs by offering:

- a range of BTEC qualification sizes, each with a clear purpose, so that there is something to suit each learner's choice of study programme and progression plans
- internationally relevant content, which is closely aligned with employer and higher-education needs
- assessments and projects chosen to help learners progress; this means that some assessments and projects are set by you to meet local needs, while others are set by Pearson, ensuring a core of skills and understanding common to all learners.

We provide a full range of support, both resources and people, to ensure that learners and teachers have the best possible experience during their course. See *Section 10 resources and support*, for details of the support we offer.

Summary of Pearson BTEC International Level 3 Qualifications in Information Technology specification Issue 3 changes

Summary of changes made between the previous issue and this current issue	Page number
Units 21–25 have been added to the qualification structures at all sizes.	Pages 6, 13, 15, 17, 19, 21, 287–345
References to 'synoptic units' and 'synoptic assessment' have been removed.	Pages 7, 8, 22, 350, 355, 366 and 389
References to 'external assessment', 'standardisation' and 'controlled assessment' have been removed. Other minor rewordings to clarify the approach to set assignments and internal assessments.	Pages 7, 8 and 368
Amendments have been made to the Unit Content for Unit 10: A1: new bullet point 2 on transactional and analytical data A3: new bullet point 1 on batch and streaming data B1: bullet point 1, sub-bullet point 3 amended to mention dashboards C2: new bullet point 2 on programming/scripting languages; bullet point 3 amended to refer to cloud-based resources and structured/ unstructured data; exemplification added to bullet point 5, sub-bullet point 2.	Pages 141–144
Amendments have been made to the Unit Content for Unit 15: A1: bullet point 1, sub-bullet point 5 amended to refer to scale A2: bullet point 2 amened to refer to containerisation A4: bullet point 2, sub-bullet point 3 amended to replace 'pay-as-you grow and chargeback' with 'consumption-based and fixed price'; two new sub-bullet points 8 and 9 added on data security and service level agreements. B3: bullet point 1, exemplification added on VPCs (etc.); new bullet point 3 added on securing the platform; bullet point 5, exemplification added on user management.	Pages 211–213
Recommendation for the level of English needed for learners studying in English added	Page 347
Appendix 1: Links to industry standards has been updated to include information about Microsoft mappings	Page 381
Appendix 2: Microsoft Fundamentals Certifications has been added and the following two appendices have been renumbered.	Page 383

Summary of Pearson BTEC International Level 3 Qualifications in Information Technology specification Issue 2 changes

Summary of changes made between Issue 1 and Issue 2	Page number
The *Assessment controls* text has been updated in the Pearson Set Assignment units and *Section 7*.	Pages 22, 27, 87, 153 and 361

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Contents

Introduction to the BTEC International Level 3 qualifications for the information technology sector

This specification contains all the information you need to deliver the Pearson BTEC International Level 3 Certificate, Subsidiary Diploma, Foundation Diploma, Diploma and Extended Diploma in Information Technology. We also refer you to other handbooks and policies. This specification includes all the units for these qualifications.

These qualifications are part of the suite of information technology qualifications offered by Pearson. In this suite, there are qualifications that focus on different progression routes, allowing learners to choose the one best suited to their aspirations.

All qualifications in the suite share some common units and assessments, which gives learners some flexibility in moving between sizes.

In the information technology sector these qualifications are:

Pearson BTEC International Level 3 Certificate in Information Technology

Pearson BTEC International Level 3 Subsidiary Diploma in Information Technology

Pearson BTEC International Level 3 Foundation Diploma in Information Technology

Pearson BTEC International Level 3 Diploma in Information Technology

Pearson BTEC International Level 3 Extended Diploma in Information Technology.

This specification signposts the other essential documents and support that you need as a centre in order 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*. Information on how we can support you with these qualifications is given in *Section 10 Resources and support*.

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

Microsoft Collaboration

The BTEC International Level 3 qualifications in IT have been developed in collaboration with Microsoft to ensure content aligns with specific certified learning opportunities.

Microsoft Fundamentals Certifications

These qualifications give a professional advantage by providing a mastering of skills in digital and cloud businesses through the attainment of industry-endorsed certification. Attainment of these certifications allow learners to pursue technical job roles.
Pearson has collaborated with Microsoft on the following:

- Microsoft Azure Data Fundamentals
- Microsoft Azure Fundamentals

A number of single units in the BTEC International Level 3 qualifications in IT *partially* align with these specific certification exam objectives, including:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 10: Big Data and Business Analytics
- Unit 15: Cloud Storage and Collaboration Tools

Further information on coverage can be found in *Appendix 1* and *2*.

Microsoft Computer Science Curriculum

Microsoft has developed a Computer Science curriculum to help embed computer science concepts across different learning stages. Pearson has collaborated with Microsoft to map existing units and develop new content. This aligns to the curriculum that accommodates cutting edge technologies and keeps pace with technological change in computer science. These units are:

- Unit 21: Introduction to Artificial Intelligence (AI)
- Unit 22: Introduction to Robotics and Automation
- Unit 23: Emerging Trends and Technologies
- Unit 24: Technical Fundamentals for Computing Professionals
- Unit 25: Full Stack Development.

More detailed information can be found in *Appendix 1* and *2*.

Information on resources to support these learning opportunities can be found on our website.

Qualifications, sizes and purposes at a glance

Title	Size and structure	Summary purpose
Pearson BTEC International Level 3 Certificate in Information Technology	180 GLH Equivalent in size to 0.5 of an International A Level. One mandatory unit that includes a Pearson Set Assignment. Mandatory content (66.7%). Learners complete a remaining optional unit to the value of 60 GLH.	This qualification is designed for learners who are interested in a basic introduction to the study of information technology alongside other fields of study, which may include other vocational or general qualifications, with a view to progressing to a wide range of higher education and employment opportunities, not necessarily in information technology.
Pearson BTEC International Level 3 Subsidiary Diploma in Information Technology	360 GLH Equivalent in size to one International A Level. Two mandatory units that include a Pearson Set Assignment. Mandatory content (50%). Learners complete remaining optional units to the value of 180 GLH.	A broad basis of study for the information technology sector. This qualification is designed for learners who are interested in an introduction to the study of creating information technology systems to manage and share information, alongside other fields of study, which may include other vocational or general qualifications, with a view to progressing to a wide range of higher education and employment opportunities, not necessarily in information technology.
Pearson BTEC International Level 3 Foundation Diploma in Information Technology	540 GLH Equivalent in size to 1.5 International A Levels. Two mandatory units that include a Pearson Set Assignment. Mandatory content (33%). Learners complete remaining optional units to the value of 360 GLH.	Designed as a one-year, full-time course, covering the fundamentals in the information technology sector, which supports progression to a work-based learning qualification in the IT sector, and/or a further year of study at Level 3. It supports progression to higher education and employment opportunities if taken as part of a programme of study that includes other BTEC International Level 3 qualifications or International A Levels.

Title	Size and structure	Summary purpose
Pearson BTEC International Level 3 Diploma in Information Technology	720 GLH Equivalent in size to two International A Levels. Two mandatory units that include a Pearson Set Assignment. Mandatory content (25%). Learners complete remaining optional units to the value of 540 GLH.	This qualification is designed to support learners who wish to study information technology as the main element alongside another area of complementary or contrasting study as part of a two-year, part-time study programme.
Pearson BTEC International Level 3 Extended Diploma in Information Technology	1080 GLH Equivalent in size to three International A Levels. Three mandatory units that include a Pearson Set Assignment. Mandatory content (27.78%). Learners complete remaining optional units to the value of 780 GLH.	This qualification is designed to be studied over two years as a full-time course. It meets entry requirements in its own right for some courses in information technology or related study such as an HNC or HND in Computing, Engineering or Business Management. This qualification could also directly lead to employment in Level 3 roles in the IT sector or via higher-education IT courses.

Structures of the qualifications at a glance

This table shows all the units and the qualifications to which they contribute. The full structure for this Pearson BTEC International Level 3 in IT is shown in *Section 2 Structure*. **You must refer to the full structure to select units and plan your programme.**

Key

	Pearson Set Assignment	M	Mandatory units	O	Optional units

Unit (number and title)	Unit size (GLH)	Certificate (180 GLH)	Subsidiary Diploma (360 GLH)	Foundation Diploma (540 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
1 Information Technology Systems – Strategy, Management and Infrastructure	120	M	M	M	M	M
2 Creating Systems to Manage Information	90		O	O	O	O
3 Using Social Media in Business	90		O	O	O	O
4 Programming	90		O	O	O	O
5 Data Modelling	60	O	O	O	O	O
6 Website Development	60		M	M	M	M
7 Mobile Apps Development	60	O	O	O	O	O
8 Computer Games Development	60	O	O	O	O	O
9 IT Project Management	90		O	O	O	O
10 Big Data and Business Analytics	60	O	O	O	O	O
11 Cyber Security and Incident Management	120			O	O	M
12 IT Technical Support and Management	60	O	O	O	O	O
13 Software Testing	60	O	O	O	O	O
14 Customising and Integrating Applications	60	O	O	O	O	O
15 Cloud Storage and Collaboration Tools	60	O	O	O	O	O
16 Digital 2D and 3D Graphics	60	O	O	O	O	O

Unit (number and title)	Unit size (GLH)	Certificate (180 GLH)	Subsidiary Diploma (360 GLH)	Foundation Diploma (540 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)
17 Digital Animation and Effects	60	O	O	O	O	O
18 The Internet of Things	60	O	O	O	O	O
19 Enterprise in IT	60	O	O	O	O	O
20 Business Process Modelling Tools	60	O	O	O	O	O
21 Introduction to Artificial Intelligence (AI)	60	O	O	O	O	O
22 Introduction to Robotics and Automation	60	O	O	O	O	O
23 Emerging Trends and Technologies	60	O	O	O	O	O
24 Technical Fundamentals for Computing Professionals	60	O	O	O	O	O
25 Full Stack Development	60	O	O	O	O	O

Qualification and unit content

Pearson has developed the content of the new BTEC International Level 3 qualifications in collaboration with employers and representatives from higher education, and relevant professional bodies. In this way, we have ensured that content is up to date and that it includes the knowledge, understanding, skills and personal attributes required in the sector.

The mandatory content ensures that all learners are following a coherent programme of study and that they acquire knowledge, understanding and skills that will be recognised and valued by higher education and employers. Learners are expected to show achievement across mandatory units as detailed in *Section 2 Structure*.

BTEC qualifications encompass applied learning that brings together knowledge and understanding with practical and technical skills. This applied learning is achieved through learners performing vocational tasks that encourage the development of appropriate vocational behaviours and transferable skills. Transferable skills are those such as communication, teamwork and research and analysis, which are valued in both higher education and the workplace. Opportunities to develop these skills are signposted in the units.

Our approach provides rigour and balance, and promotes the ability to apply learning immediately in new contexts.

Centres should ensure that content, for example content that references regulation, legislation, policies and regulatory/standards organisations, is kept up to date. The units include guidance on approaches to breadth and depth of coverage, which can be modified to ensure that content is current and reflects international variations.

Assessment

Assessment is designed to fit the purpose and objective of the qualification. It includes a range of assessment types and styles suited to vocational qualifications in the sector. All assessment is internal but mandatory units have extra controls on assessment and are assessed using Pearson Set Assignments.

Set assignment units

Mandatory units in the qualifications are assessed using a set assignment. (This is true also for Unit 11, which is mandatory for the Extended Diploma but optional in some other sizes.)

Set assignment units are subject to external standards verification processes common to all BTEC units. By setting an assignment for some units, we can ensure that all learners take the same assessment for a specific unit. Learners are permitted to resit set assignment units during their programme. Please see *Section 6 Internal assessment* for further information.

Set assignments are available from September each year and are valid for one year only. For detailed information on the Pearson Set Assignment, please see the table in *Section 2 Structure*. For further information on preparing for assessment, see *Section 5 Assessment structure*.

Internal assessment

All units in the sector are internally assessed and subject to external standards verification. Before you assess you will need to become an approved centre, if you are not one already. You will need to prepare to assess using the guidance in *Section 6 Internal assessment*.

For units where there is no Pearson Set Assignment, you select the most appropriate assessment styles according to the learning set out in the unit. This ensures that learners are assessed using a variety of styles to help them develop a broad range of transferable skills. Learners could be given opportunities to:

- write up the findings of their own research
- use case studies to explore complex or unfamiliar situations
- carry out projects for which they have choice over the direction and outcomes
- demonstrate practical and technical skills using appropriate processes etc.

For these units, Pearson will provide an Authorised Assignment Brief that you can use. You will make grading decisions based on the requirements and supporting guidance given in the units. Learners may not make repeated submissions of assignment evidence. For further information, please see *Section 6 Internal assessment*.

Language of assessment

Assessment of the units for these qualifications is available in English but can be translated as necessary.

A learner taking the qualification/s may be assessed in sign language where it is permitted for the purpose of reasonable adjustment. For information on reasonable adjustments, see *Section 7 Administration arrangements*.

Grading for units and qualifications

Achievement of the qualification requires demonstration of depth of study in each unit, assured acquisition of a range of practical skills required for employment or for progression to higher education, and successful development of transferable skills. Learners who achieve a qualification will have achieved across mandatory units.

Units are assessed using a grading scale of Distinction (D), Merit (M), Pass (P) and Unclassified (U). All mandatory and optional units contribute proportionately to the overall qualification grade, for example a unit of 120 GLH will contribute double that of a 60 GLH unit.

Qualifications in the suite are graded using a scale of P to D*, **or** PP to D*D*, **or** PPP to D*D*D*. Please see *Section 9 Understanding the qualification grade*, for more details. The relationship between qualification grading scales and unit grades will be subject to regular review as part of Pearson's standards monitoring processes, on the basis of learner performance and in consultation with key users of the qualifications.

1 Qualification purpose and progression

Pearson BTEC International Level 3 qualifications in Information Technology

Who are these qualifications for?

The Pearson BTEC International Level 3 qualifications in Information Technology are designed for learners who are interested in the study of information technology, with a view to progressing to a range of graduate entry higher-education courses and/or working within the IT industry on completion of this qualification.

Learners will have exposure to a wide range of IT topics that will enhance their progression to higher education in this sector, a complementary sector or a contrasting sector, and ultimately lead to employment.

Which size qualification to choose?

Choosing the most suitable size of qualification will depend on the learner's broader programme of study. Learners may take the Diploma or Extended Diploma for a broader understanding of study as their main programme of study, while a learner who selects a smaller qualification, such as the Certificate or Subsidiary Diploma, may choose to combine it with qualifications from other sectors, in order to support their desired progression. Smaller qualifications are also suitable for learners who are in employment and studying part time.

Qualification structures have been designed to enable a learner who starts with the smallest qualification to progress easily to the larger qualifications.

What do these qualifications cover?

The content of these qualifications has been designed to support progression to particular roles in information systems, either directly into entry-level roles linked to these occupational areas or, more likely, via particular higher-education routes in these particular areas. The qualification content has been designed in consultation with employers, professional bodies and higher-education providers to ensure that the content is appropriate for the progression routes identified.

All learners will be required to take mandatory content that is directly relevant to progression routes in all of the identified areas. Depending on the chosen course, these may include the following:

- Information Technology Systems – Strategy, Management and Infrastructure
- Website Development
- Cyber Security and Incident Management.

In addition, learners can have the flexibility to take a wide range of optional units, for example:

- Creating Systems to Manage Information
- Using Social Media in Business
- Programming
- Data Modelling
- Mobile Apps Development
- Computer Games Development
- IT Project Management
- Big Data and Business Analytics
- IT Technical Support and Management
- Software Testing
- Customising and Integrating Applications
- Cloud Storage and Collaboration Tools
- Digital 2D and 3D Graphics
- Digital Animation and Effects
- The Internet of Things
- Enterprise in IT
- Business Process Modelling Tools.

What could these qualifications lead to?

These qualifications give learners the opportunity to progress to higher education to study a BTEC Higher National in Computing, a degree in an information technology discipline or a degree where information technology related skills and knowledge may be advantageous, such as business studies.

They also support learners who want to develop knowledge and skills needed for vocational apprenticeship roles, and allow for progression to job opportunities at trainee/entry levels. Jobs available in these areas include:

- Software Developer
- Web/Content Developer
- Mobile App Designer
- Games Designer
- Programmer
- IT/Business Analysis Support.

These qualifications are recognised by higher-education institutions as fully meeting admission requirements to many relevant courses in a variety of areas of the IT sector, for example:

- HNC in Interactive Media
- FdSC in Business Computing
- HND in Engineering
- BSc (Hons) in Information Management for Business
- BA (Hons) in Accounting and Finance
- BSc (Hons) in Information Management for Business.

NB: learners should always check the entry requirements for degree programmes with the relevant higher education provider.

How do these qualifications provide transferable employability skills?

In the BTEC International Level 3 units, there are opportunities during the teaching and learning phase to give learners practise in developing employability skills. Where we refer to employability skills in this specification, we are generally referring to skills in the following three main categories:

- **cognitive and problem-solving skills** – using critical thinking, approaching non-routine problems, applying expert and creative solutions, using systems and technology
- **interpersonal skills** – communicating, working collaboratively, negotiating and influencing, self-presentation
- **intrapersonal skills** – self-management, adaptability and resilience, self-monitoring and development.

There are also specific requirements in some units for assessment of these skills where relevant, for example where learners are required to undertake real or simulated activities. These skills are indicated in the units and in *Appendix 2: Transferable employability skills*.

How do the qualifications provide transferable knowledge and skills for higher education?

All BTEC International Level 3 qualifications provide transferable knowledge and skills that prepare learners for progression to university. The transferable skills that universities value include:

- the ability to learn independently
- the ability to research actively and methodically
- the ability to give presentations and be active group members.

BTEC learners can also benefit from opportunities for deep learning, where they are able to make connections across units and select areas of interest for detailed study. BTEC International Level 3 qualifications provide a vocational context in which learners can develop the knowledge and skills required for particular degree courses, including:

- analytical skills
- creative development
- preparation for assessment methods used in a degree.

2 Structure

Qualification structures

The structures for the qualifications in this specification are:

- Pearson BTEC International Level 3 Certificate in Information Technology
- Pearson BTEC International Level 3 Subsidiary Diploma in Information Technology
- Pearson BTEC International Level 3 Foundation Diploma in Information Technology
- Pearson BTEC International Level 3 Diploma in Information Technology
- Pearson BTEC International Level 3 Extended Diploma in Information Technology.

Pearson BTEC International Level 3 Certificate in Information Technology

Mandatory units

There is one mandatory unit that is a set-assignment assessment unit. Learners must complete and achieve a Pass or above in the mandatory unit.

Optional units

Learners must complete at least one optional unit.

Pearson BTEC International Level 3 Certificate in Information Technology				
Unit number	**Unit title**	**GLH**	**Type**	**How assessed**
Mandatory unit – learners complete and achieve this unit				
1	Information Technology Systems – Strategy, Management and Infrastructure	**120**	**Mandatory**	Set assignment
Optional units – learners complete one unit				
5	Data Modelling	**60**	**Optional**	Internal
7	Mobile Apps Development	**60**	**Optional**	Internal
8	Computer Games Development	**60**	**Optional**	Internal
10	Big Data and Business Analytics	**60**	**Optional**	Internal
12	IT Technical Support and Management	**60**	**Optional**	Internal
13	Software Testing	**60**	**Optional**	Internal
14	Customising and Integrating Applications	**60**	**Optional**	Internal
15	Cloud Storage and Collaboration Tools	**60**	**Optional**	Internal
16	Digital 2D and 3D Graphics	**60**	**Optional**	Internal

Optional units – learners complete one unit *(continued)*				
17	Digital Animation and Effects	**60**	**Optional**	Internal
18	The Internet of Things	**60**	**Optional**	Internal
19	Enterprise in IT	**60**	**Optional**	Internal
20	Business Process Modelling Tools	**60**	**Optional**	Internal
21	Introduction to Artificial Intelligence (AI)	**60**	**Optional**	Internal
22	Introduction to Robotics and Automation	**60**	**Optional**	Internal
23	Emerging Trends and Technologies	**60**	**Optional**	Internal
24	Technical Fundamentals for Computing Professionals	**60**	**Optional**	Internal
25	Full Stack Development	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Subsidiary Diploma in Information Technology

Mandatory units

There are two mandatory units that are set-assignment assessment units. Learners must complete and achieve a Pass or above in the two mandatory units.

Optional units

Learners must complete optional units to a minimum value of 180 GLH.

Pearson BTEC International Level 3 Subsidiary Diploma in Information Technology				
Unit number	**Unit title**	**GLH**	**Type**	**How assessed**
Mandatory unit – learners complete and achieve these units				
1	Information Technology Systems – Strategy, Management and Infrastructure	**120**	**Mandatory**	Set assignment
6	Website Development	**60**	**Mandatory**	Set assignment
Optional units – learners complete optional units to a minimum value of 180 GLH				
2	Creating Systems to Manage Information	**90**	**Optional**	Internal
3	Using Social Media in Business	**90**	**Optional**	Internal
4	Programming	**90**	**Optional**	Internal
5	Data Modelling	**60**	**Optional**	Internal
7	Mobile Apps Development	**60**	**Optional**	Internal
8	Computer Games Development	**60**	**Optional**	Internal
9	IT Project Management	**90**	**Optional**	Internal
10	Big Data and Business Analytics	**60**	**Optional**	Internal
12	IT Technical Support and Management	**60**	**Optional**	Internal
13	Software Testing	**60**	**Optional**	Internal
14	Customising and Integrating Applications	**60**	**Optional**	Internal
15	Cloud Storage and Collaboration Tools	**60**	**Optional**	Internal
16	Digital 2D and 3D Graphics	**60**	**Optional**	Internal
17	Digital Animation and Effects	**60**	**Optional**	Internal
18	The Internet of Things	**60**	**Optional**	Internal
19	Enterprise in IT	**60**	**Optional**	Internal
20	Business Process Modelling Tools	**60**	**Optional**	Internal

Optional units – learners complete optional units to a minimum value of 180 GLH *(continued)*				
21	Introduction to Artificial Intelligence (AI)	**60**	**Optional**	Internal
22	Introduction to Robotics and Automation	**60**	**Optional**	Internal
23	Emerging Trends and Technologies	**60**	**Optional**	Internal
24	Technical Fundamentals for Computing Professionals	**60**	**Optional**	Internal
25	Full Stack Development	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Foundation Diploma in Information Technology

Mandatory units

There are two mandatory units that are set-assignment assessment units. Learners must complete and achieve a Pass or above in the two mandatory units.

Optional units

Learners must complete optional units to a minimum value of 360 GLH.

Pearson BTEC International Level 3 Foundation Diploma in Information Technology				
Unit number	**Unit title**	**GLH**	**Type**	**How assessed**
Mandatory unit – learners complete and achieve these units				
1	Information Technology Systems – Strategy, Management and Infrastructure	**120**	**Mandatory**	Set assignment
6	Website Development	**60**	**Mandatory**	Set assignment
Optional units – learners complete optional units to a minimum value of 360 GLH				
2	Creating Systems to Manage Information	**90**	**Optional**	Internal
3	Using Social Media in Business	**90**	**Optional**	Internal
4	Programming	**90**	**Optional**	Internal
5	Data Modelling	**60**	**Optional**	Internal
7	Mobile Apps Development	**60**	**Optional**	Internal
8	Computer Games Development	**60**	**Optional**	Internal
9	IT Project Management	**90**	**Optional**	Internal
10	Big Data and Business Analytics	**60**	**Optional**	Internal
11	Cyber Security and Incident Management	**120**	**Optional**	Set assignment
12	IT Technical Support and Management	**60**	**Optional**	Internal
13	Software Testing	**60**	**Optional**	Internal
14	Customising and Integrating Applications	**60**	**Optional**	Internal
15	Cloud Storage and Collaboration Tools	**60**	**Optional**	Internal
16	Digital 2D and 3D Graphics	**60**	**Optional**	Internal
17	Digital Animation and Effects	**60**	**Optional**	Internal

Optional units – learners complete optional units to a minimum value of 360 GLH *(continued)*				
18	The Internet of Things	**60**	**Optional**	Internal
19	Enterprise in IT	**60**	**Optional**	Internal
20	Business Process Modelling Tools	**60**	**Optional**	Internal
21	Introduction to Artificial Intelligence (AI)	**60**	**Optional**	Internal
22	Introduction to Robotics and Automation	**60**	**Optional**	Internal
23	Emerging Trends and Technologies	**60**	**Optional**	Internal
24	Technical Fundamentals for Computing Professionals	**60**	**Optional**	Internal
25	Full Stack Development	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Diploma in Information Technology

Mandatory units

There are two mandatory units that are set-assignment assessment units. Learners must complete and achieve a Pass or above in the two mandatory units.

Optional units

Learners must complete optional units to a minimum value of 540 GLH.

Pearson BTEC International Level 3 Diploma in Information Technology				
Unit number	**Unit title**	**GLH**	**Type**	**How assessed**
Mandatory unit – learners complete and achieve these units				
1	Information Technology Systems – Strategy, Management and Infrastructure	**120**	**Mandatory**	Set assignment
6	Website Development	**60**	**Mandatory**	Set assignment
Optional units – learners complete optional units to a minimum value of 540 GLH				
2	Creating Systems to Manage Information	**90**	**Optional**	Internal
3	Using Social Media in Business	**90**	**Optional**	Internal
4	Programming	**90**	**Optional**	Internal
5	Data Modelling	**60**	**Optional**	Internal
7	Mobile Apps Development	**60**	**Optional**	Internal
8	Computer Games Development	**60**	**Optional**	Internal
9	IT Project Management	**90**	**Optional**	Internal
10	Big Data and Business Analytics	**60**	**Optional**	Internal
11	Cyber Security and Incident Management	**120**	**Optional**	Set assignment
12	IT Technical Support and Management	**60**	**Optional**	Internal
13	Software Testing	**60**	**Optional**	Internal
14	Customising and Integrating Applications	**60**	**Optional**	Internal
15	Cloud Storage and Collaboration Tools	**60**	**Optional**	Internal
16	Digital 2D and 3D Graphics	**60**	**Optional**	Internal
17	Digital Animation and Effects	**60**	**Optional**	Internal
18	The Internet of Things	**60**	**Optional**	Internal
19	Enterprise in IT	**60**	**Optional**	Internal
20	Business Process Modelling Tools	**60**	**Optional**	Internal

Optional units – learners complete optional units to a minimum value of 540 GLH *(continued)*				
21	Introduction to Artificial Intelligence (AI)	**60**	**Optional**	Internal
22	Introduction to Robotics and Automation	**60**	**Optional**	Internal
23	Emerging Trends and Technologies	**60**	**Optional**	Internal
24	Technical Fundamentals for Computing Professionals	**60**	**Optional**	Internal
25	Full Stack Development	**60**	**Optional**	Internal

Pearson BTEC International Level 3 Extended Diploma in Information Technology

Mandatory units

There are three mandatory units that are set-assignment assessment units. Learners must complete and achieve a Pass or above in the three mandatory units.

Optional units

Learners must complete optional units to a minimum value of 780 GLH.

Pearson BTEC International Level 3 Extended Diploma in Information Technology				
Unit number	**Unit title**	**GLH**	**Type**	**How assessed**
Mandatory unit – learners complete and achieve this unit				
1	Information Technology Systems – Strategy, Management and Infrastructure	**120**	**Mandatory**	Set assignment
6	Website Development	**60**	**Mandatory**	Set assignment
11	Cyber Security and Incident Management	**120**	**Mandatory**	Set assignment
Optional units – learners complete optional units to a minimum value of 780 GLH				
2	Creating Systems to Manage Information	**90**	**Optional**	Internal
3	Using Social Media in Business	**90**	**Optional**	Internal
4	Programming	**90**	**Optional**	Internal
5	Data Modelling	**60**	**Optional**	Internal
7	Mobile Apps Development	**60**	**Optional**	Internal
8	Computer Games Development	**60**	**Optional**	Internal
9	IT Project Management	**90**	**Optional**	Internal
10	Big Data and Business Analytics	**60**	**Optional**	Internal
12	IT Technical Support and Management	**60**	**Optional**	Internal
13	Software Testing	**60**	**Optional**	Internal
14	Customising and Integrating Applications	**60**	**Optional**	Internal
15	Cloud storage and Collaboration Tools	**60**	**Optional**	Internal
16	Digital 2D and 3D Graphics	**60**	**Optional**	Internal
17	Digital Animation and Effects	**60**	**Optional**	Internal
18	The Internet of Things	**60**	**Optional**	Internal

Optional units – learners complete optional units to a minimum value of 780 GLH *(continued)*				
19	Enterprise in IT	**60**	**Optional**	Internal
20	Business Process Modelling Tools	**60**	**Optional**	Internal
21	Introduction to Artificial Intelligence (AI)	**60**	**Optional**	Internal
22	Introduction to Robotics and Automation	**60**	**Optional**	Internal
23	Emerging Trends and Technologies	**60**	**Optional**	Internal
24	Technical Fundamentals for Computing Professionals	**60**	**Optional**	Internal
25	Full Stack Development	**60**	**Optional**	Internal

Set assignment units

This is a summary of the type and availability of set assignment units. For more information, see *Section 5 Assessment structure*, and the units and sample assessment materials.

Unit	Type	Availability
Unit 1: Information Technology Systems – Strategy, Management and Infrastructure	• An assignment set by Pearson and marked by the centre. • The advised period is 20 hours. • Completed using a computer.	**Two available for each one-year period.**
Unit 6: Website Development	• An assignment set by Pearson and marked by the centre. • The advised period is 20 hours. • Completed using a computer.	**Two available for each one-year period.**
Unit 11: Cyber Security and Incident Management	• An assignment set by Pearson and marked by the centre. • The advised period is 20 hours. • Completed using a computer.	**Two available for each one-year period.**

Employer involvement in assessment and delivery

You are encouraged to give learners opportunities to be involved with employers. For more information, please see *Section 4 Planning your programme*.

3 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 sector. Numbers may not be sequential for an individual qualification.
Unit title	This is the formal title that we always use, it appears on certificates.
Level	All units are at Level 3.
Unit type	This shows if the unit is internal or assessed using a Pearson Set Assignment. See structure information in *Section 2 Structure* for details.
Guided Learning Hours (GLH)	Units may have a GLH value of 120, 90 or 60. This indicates the numbers of hours of teaching, directed activity and assessment expected. It also shows the weighting of the unit in the final qualification grade.
Unit in brief	A brief formal statement on the content of the unit that is helpful in understanding its role in the qualification. You can use this in summary documents, brochures etc.
Unit introduction	This is written with learners in mind. It indicates why the unit is important, how learning is structured and how it might be applied when they progress to employment or higher education.
Assessment	For internal set assignment units, this section states whether set assignments are required to be completed.
Learning aims	These help to define the scope, style and depth of learning of the unit. You can see where learners should be learning standard requirements ('understand') or where they should be actively researching ('investigate'). You can find out more about the verbs we use in learning aims in *Appendix 3: Glossary of terms used*.
Summary of unit	This section helps teachers to see at a glance the main content areas given against the learning aims and the structure of the assessment. The content areas and structure of assessment must be covered. The forms of evidence given are suitable to fulfil the requirement.

Section	Explanation
Content	This section sets out the required teaching content of the unit. Content is compulsory except when shown as 'e.g.'. Learners should be asked to complete summative assessment only after the teaching content for the unit or learning aim(s) has been covered.
Assessment criteria	Each learning aim has Pass and Merit criteria. Each assignment has at least one Distinction criterion. A full glossary of terms used is given in *Appendix 3: Glossary of terms used.* All assessors need to understand our expectations of the terms used. Distinction criteria represent outstanding performance in the unit. Some criteria require learners to draw together learning from across the learning aims.
Essential information for assignments	This shows the maximum number of assignments that may be used for the unit to allow for effective summative assessment and how the assessment criteria should be used to assess performance. For set assignment units, this section will include any conditions for taking the assignment.
Further information for teachers and assessors	This section gives you information to support the implementation of assessment. It is important that this is read carefully alongside the assessment criteria, as the information will help with interpretation of the requirements.
Resource requirements	Any specific resources that you need to be able to teach and assess are listed in this section. For information on support resources, see *Section 10 Resources and support*.
Essential information for assessment decisions	This section gives guidance on and examples for each learning aim or assignment of the expectations for Pass, Merit and Distinction standard.
Assessment controls	This section gives details of the rules that learners need to abide by when taking the assessment.
Links to other units	This section shows you the main relationships between different units. This helps you to structure your programme and make best use of available materials and resources.
Employer involvement	This section gives you information on the units, which can be used to involve learners with employers. This will help you to identify the kind of involvement that is likely to be most successful.
Opportunities to develop transferable employability skills	This section gives you guidance on how transferable employability skills might be developed in teaching and assessment of the unit.

Index of units

This section contains all the units developed for these qualifications. Please refer to *pages 4–5* to check which units are available in all qualifications in the IT sector.

Unit 1: Information Technology Systems – Strategy, Management and Infrastructure

Level: 3
Unit type: Internal set assignment
Guided learning hours: 120

Unit in brief

Learners study the role of computer systems and the implications of their use in personal and professional situations.

Unit introduction

Information technology (IT) systems play a significant role in the world around us. They play a key part in almost everything we do. They give individuals and organisations opportunities to access goods, information and services from around the world to an extent not possible before. Having a sound understanding of how to select and use appropriate IT systems will benefit you personally and professionally.

You will explore the relationships between the hardware and software that form an IT system. You will look at the way that systems work individually and together, as well as the relationship between the user and the system. You will examine issues related to the use of IT systems and the impact that they have on organisations and their stakeholders. You will explore how IT systems enable organisations to access data, information and users locally and globally.

This unit will give you a fundamental understanding of all areas of IT, supporting your progression to an IT-related higher education course.

This unit also provides partial coverage to content from the Microsoft Azure Data Fundamentals Certification.

To complete the set assignment in this unit, you will need to draw on, and apply, your learning from across key content areas.

Assessment

This unit has a set assignment. Learners must complete a Pearson Set Assignment Brief.

Learning aims

In this unit you will:

A Explore how IT infrastructure meets the needs of organisations and their stakeholders

B Understand how organisations make use of data and information

C Develop policies for the use of IT within an organisation.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore how IT infrastructure meets the needs of organisations and their stakeholders	**A1** Purpose and functions of organisations **A2** Digital devices, their functions and use **A3** Peripheral devices and media **A4** Computer software in an IT system **A5** Connectivity **A6** Networks **A7** Issues relating to transmission of data **A8** Online systems **A9** Emerging technologies	This unit is assessed through a Pearson Set Assignment.
B Understand how organisations make use of data and information	**B1** Data and information in an organisation **B2** Online communities **B3** Using and manipulating data	
C Develop policies for the use of IT within an organisation	**C1** Threats to data, information and systems **C2** Protecting data **C3** Moral and ethical issues **C4** Legal issues **C5** Professional guidelines and codes of practice **C6** Managing information technology within organisations	

Content

Learning aim A: Explore how IT infrastructure meets the needs of organisations and their stakeholders

A1 Purpose and functions of organisations

Apply an understanding of information technology (IT) to identify the infrastructure requirements of organisations in a range of sectors and vocational-based scenarios.

- Purpose and differences of organisations that provide a service and/or a product.
- Infrastructure requirements driven by the priorities of an organisation.
- Identification and definition of features and characteristics of the infrastructure required for key tasks carried out by functions of an organisation:
  - manufacturing of products
  - delivering services
  - supply chain management
  - marketing and sales
  - customer relations
  - resource management
  - staff recruitment
  - staff management
  - support and financial.

A2 Digital devices, their functions and uses

The features and uses of digital devices in IT systems to meet the needs of organisations and their stakeholders.

- Digital devices that form part or all of IT systems:
  - personal computers (desktops and laptops)
  - mobile devices, e.g. smartphones, modular smartphones, specialist phones, tablets, laptops, wearable computers
  - servers (physical, virtual)
  - entertainment systems, e.g. televisions, projectors, DVD players/recorders, Blu-ray players, personal video recorders (PVR), set-top boxes (STB), media stations, sound systems
  - digital cameras (still, video)
  - navigation systems
  - wearable computers, e.g. smartwatches, fitness trackers
  - data capture and collection systems, e.g. barcode scanners, RFID (radio frequency identification), sensors, weather stations
  - communication devices and systems.
- The function and use of digital devices for:
  - education and training
  - personal use
  - social use
  - retail use
  - organisational use, e.g. business operations, internal and external dissemination of information
  - creative tasks.

A3 Peripheral devices and media

The features and uses of peripheral devices and media in IT systems to meet the needs of individuals and organisations.

- Peripheral devices used with other digital devices to form part of an IT system:
  - input devices, e.g. keyboard, touch screen, pointing devices (mouse, stylus, touchpad, graphics tablets, microphone, scanner (2D and 3D), cameras, sensors)
  - output devices, e.g. screens, projectors, printers (2D and 3D), actuators, motors, accessibility devices
  - storage devices, e.g. USB flash drives, memory cards, hard drives (internal and external), optical drives/discs, magnetic tape drives
  - accessibility devices, e.g. alternative keyboards, sip-and-puff systems, wands and sticks, braille embossers.
- Manual and automatic data processing.
- Characteristics and implications of storage media used to form part of an IT system, e.g. magnetic, solid state, optical.

A4 Computer software in an IT system

The concepts and implications of the use of, and relationships between, hardware and software that form large- and small-scale IT systems and their impact on organisations and their stakeholders.

- Types of operating system, e.g. real time, embedded, multi-user.
- The role of the operating system in managing:
  - networking
  - security
  - memory management
  - multitasking
  - device drivers.
- Factors affecting the choice and use of user interfaces (graphical, command line, menu-based, adapted):
  - the features and characteristics of different interfaces
  - how and when they are used
  - how interfaces affect users
  - how interfaces affect features and performance of computer systems.
- Factors affecting use and performance of an operating system, e.g. amount of data being processed, hardware specifications, compatibility with other systems.
- Utility software (including: antivirus/anti-malware, backup software, compression tools, disk analysers, disk defragmenters, disk partitioners, encryption software, file managers, firewall, network utilities):
  - the purpose, features and uses of utility software
  - factors affecting the choice, use and performance of utility software.
- Application software, including: communications software, computer-aided design (CAD), database management systems (DBMS), digital graphics and animation, enterprise resource packages (ERP), entertainment software, office software:
  - the purpose, features and uses of application software
  - factors affecting the choice, use and performance of application software.

- The principles and implications of open source and proprietary operating systems and software.
- The features of common file types and formats used for:
  - images, e.g. GIF, PNG, JPEG, RAW, SVG
  - videos, e.g. MPEG, AVI
  - audio, e.g. MP3, WAV
  - application software, e.g. DOC, RTF, XLS, XML, PDF.
- The implications on IT systems, organisations and their stakeholders of the use and selection of file types and formats.

A5 Connectivity

The concepts, process and implications of transferring data within and between IT systems.

- Wireless and wired methods of connecting devices and transmitting data within and between IT systems:
  - wired connection and transmission methods, e.g. Ethernet, USB, fibre optic, HDMI, DVI
  - wireless connection and transmission methods, e.g. Bluetooth®, Wi-Fi, NFC, infrared, mobile/cellular networks.
- The features of connection types and how they can meet the needs of individuals and organisations.
- The implications of selecting and using different connection types.
- The impact of connection types on the performance of an IT system.

A6 Networks

The concepts and implications for organisations and their stakeholders of connecting devices to form a network.

- The features, use and purpose of different networks:
  - personal area network (PAN)
  - local area network (LAN)
  - wide area network (WAN)
  - virtual private network (VPN)
  - internet.
- Factors affecting the choice of network:
  - user experience, e.g. ease of use, performance, availability, accessibility
  - user needs
  - specifications
  - connectivity, e.g. availability, signal strength, potential bandwidth, reliability
  - cost
  - efficiency
  - compatibility
  - implementation, e.g. timescales, testing, downtime
  - productivity
  - security.
- The features of component parts of a network and how these affect the performance of an IT system, e.g. router, switch, Ethernet cables, wireless access point.

A7 Issues relating to transmission of data

How the features and processes of data transmission affect the use and performance of IT systems.

- Protocols used to govern and control data transmission for common tasks, e.g. HTTP, HTTPS, POP3, IMAP4, SMTP, VoIP, FTP, TCP/IP.
- Security issues and considerations when transmitting data over different connection types and networks.
- Factors affecting bandwidth and latency, e.g. connection type, number of users, protocol used, distance from server, data/signal conversion.
- The implications of bandwidth and latency on the use and performance of an IT system.
- Types of compression:
  - lossy, e.g. MP3, MP4, JPEG
  - lossless, e.g. FLAC. GIF. PNG, zip.
- The applications and implications of data compression.
- The use and implications of codecs when using and transmitting audio and video in digital format.

A8 Online systems

The features, impact and implications of the use of online IT systems to store data and perform tasks.

- The personal and professional uses and applications of cloud storage.
- The personal and professional uses and applications of cloud computing.
- The impact and implications on individuals of using cloud storage and computing.
- The impact and implications on organisations of using cloud storage and computing.
- Systems that enable and support remote working:
  - VPNs
  - remote desktop technologies.
- Factors affecting the use and selection of online systems:
  - security
  - cost
  - ease of use
  - features
  - connectivity.

A9 Emerging technologies

The features of the new and emerging technologies and their implications for organisations and their stakeholders.

- Developments in digital devices, e.g. smartphones, activity trackers, portable computing.
- Developments in networks and connectivity, e.g. 4G/5G, IoT, virtualisation, containerisation.
- Developments in modelling and data interrogation, e.g. augmented reality, virtual reality, data warehousing, machine learning.

Learning aim B: Understand how organisations make use of data and information

B1 Data and information in an organisation

Understand how and why organisations use data and information at different levels of the organisation.

- The interrelationship (and differences) between data and information and how this affects the information generated.
- The features, characteristics and implications of the requirements for data and information at different levels of an organisation:
  - strategic level, e.g. changing markets, impact of changes such as setting up new offices, global and national trends
  - management level, e.g. customer data, employee data, suppliers, financial performance data
  - operational level, e.g. available resources, stock levels, customer numbers, cash flow, 'just in time' systems.
- The data used to define organisational requirements and devise IT systems and solutions.
- Data and information needs at different levels of an organisation in relation to:
  - sector and type of the organisation
  - size of the organisation
  - services and/or products the organisation provides
  - aims and goals of an organisation
  - defining the scope of a customer's needs
  - managing day-to-day tasks and services
  - ensuring continuation and provision of service and/or product
  - identifying and planning improvements
  - setting and developing policy
  - communication with staff, colleagues and/or customers
  - customers
  - staff
  - location
  - operational tasks, including those performed by individuals and IT systems.
- Data source and data set requirements of organisations and IT systems:
  - volume (the quantity of data that is generated)
  - velocity (the speed of generation of data)
  - variety (the mixture of data to be processed)
  - veracity (the quality and trustworthiness of the data)
  - value (the financial and operational worth of the data).

B2 Online communities

The features of online communities and the implications of their use to generate, share and access data and information.

- Ways of communicating and interacting with online communities:
  - social media
  - blog, microblog, vlog
  - wiki
  - chatrooms

  - instant messaging
  - podcasts
  - forums.
- The implications for stakeholders of using and accessing online communities:
  - user experience – ease of use, performance, availability, accessibility
  - meeting needs
  - cost
  - privacy
  - security.
- The implications for organisations of using and accessing online communities:
  - employee and customer experience – ease of use, performance, availability, accessibility
  - customer needs
  - cost
  - implementation – timescales, testing
  - replacement or integration with current systems
  - productivity
  - working practices
  - security.

B3 Using and manipulating data

The processes and implications for organisations and their stakeholders of accessing and using data and information in digital form.

- Sources of data:
  - primary
  - secondary.
- Judging and ensuring the reliability of data.
- The characteristics and implications of methods of collecting data and opinions:
  - observations
  - survey
  - questionnaire
  - focus groups
  - interview.
- Reasons for ensuring data accuracy.
- Methods of ensuring data accuracy, e.g. verification, validation, automatic error correction systems.
- Methods of extracting and sorting data.
- Numerical and data modelling.
- Presenting data and results.
- The characteristics and implications of user interfaces for data collection and processing systems:
  - ease of use
  - accessibility
  - error reduction
  - intuitiveness.

Learning aim C: Develop policies for the use of IT within an organisation

C1 Threats to data, information and systems

The implications of accidental and malicious threats to the security and integrity of data, held in, and used by, IT systems.

- The characteristics of threats to data:
  - viruses and other malware
  - hackers
  - phishing
  - accidental damage.
- The impact of threats to data, information and systems on individuals.
- The impact of threats to data, information and systems on organisations.

C2 Protecting data

The features, uses and implications of systems and procedures used to protect the data of individuals and organisations.

- Processes and implications of techniques for protecting data and systems:
  - file permissions
  - access levels
  - backup and recovery procedures
  - passwords
  - physical access control
  - digital certificates
  - protocols.
- The features, characteristics and implications of using antivirus software to protect data.
- The features, characteristics and implications of using firewalls to protect data.
- The features, applications and implications of encryption methods used to protect:
  - stored data
  - data during transmission.

C3 Moral and ethical issues

The implications for organisations and their stakeholders of moral and ethical factors of using information technology.

- The moral and ethical factors of the use of information technology:
  - privacy
  - environmental
  - unequal access to information technology
  - online behaviour and netiquette
  - globalisation
  - freedom of speech and censorship
  - acceptable use
  - ethical hacking (white hat and grey hat)
  - protection of data.

C4 Legal issues

The legal issues relating to the use of IT systems and the implications for organisations and their stakeholders.

- The role of current legislation (and subsequent additions and amendments) in protecting users and their data from attack and misuse in relation to:
  - computer misuse
  - copyright and intellectual property
  - health and safety
  - data protection
  - consumer rights
  - accessibility.

C5 Professional guidelines and codes of practice

How organisations implement and make use of professional guidelines and codes of practice and the implications of these on the organisation and their stakeholders.

- The purpose and role of codes of practice produced by professional bodies for the use of IT systems.
- The impact of codes of practice on individuals and organisations.
- Guidelines designed to ensure the accessibility and quality of IT systems:
  - ISO (International Organisation for Standardisation) standards
  - Web Content Accessibility Guidelines (WCAG) 1.0 and 2.0 (World Wide Web Consortium (W3C®)).

C6 Managing information technology within organisations

Understand the concepts and challenges of managing infrastructure, data, information and users.

- The role and implications of acceptable use policies within an organisation.
- Contents of policies to manage IT infrastructure, data, information and users:
  - user management, e.g. security, acceptable use
  - customer management and support, e.g. FAQs, incident resolution flow charts, use of social media and other communications
  - asset management, e.g. issue reporting procedures, maintenance schedules, issue logs, remote and local deployment of software
  - incident management, e.g. backup and recovery procedures, communication with public and authorities
  - performance metrics, including collection and analysis.
- Implications for organisations of using in-house and external systems for provision of IT systems:
  - service-level agreements (SLAs)
  - hardware and software requirements
  - cost
  - availability
  - scalability
  - legal ownership of data and jurisdiction
  - problems encountered by data and processing residing in multiple jurisdictions
  - issues relating to data and processing residing regions that may not have appropriate laws covering protection and use of data implementation.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Explore how IT infrastructure meets the needs of organisations and their stakeholders</td><td rowspan="3">A.D1 Evaluate how IT infrastructure can impact an organisation and its stakeholders.</td></tr>
<tr><td>A.P1 Explain ways in which software can meet the needs of an organisation and its stakeholders.
A.P2 Explain ways in which hardware can meet the needs of an organisation and its stakeholders.
A.P3 Explain ways in which the use of data connections and networks can meet the needs of an organisation and its stakeholders.</td><td>A.M1 Analyse how IT infrastructure can impact an organisation and its stakeholders.</td></tr>
<tr><td colspan="2">Learning aim B: Understand how organisations make use of data and information</td></tr>
<tr><td>B.P4 Explain ways in which data is used in an organisation.
B.P5 Explain ways in which information is used and distributed by an organisation, both internally and externally.</td><td>B.M2 Analyse how data and information are used in an organisation, both internally and externally.</td><td rowspan="3">BC.D2 Evaluate the impact of the use of data and information on an organisation, its stakeholders and related policies.
BC.D3 Justify decisions and approaches taken when developing policies.</td></tr>
<tr><td colspan="2">Learning aim C: Develop policies for the use of IT within an organisation</td></tr>
<tr><td>C.P6 Describe internal and external threats, to data and information, in an organisation.
C.P7 Describe procedures to be implemented in an organisation to allow them to protect data and information.
C.P8 Describe procedures to be implemented in an organisation to allow them to operate in legal, moral and ethical ways.</td><td>C.M3 Analyse how threats, and mitigation of those threats, impact an organisation and its stakeholders.
C.M4 Analyse how suggested procedures that ensure an organisation works in a legal and ethical way would impact on an organisation and its stakeholders.</td></tr>
</table>

Essential information for assignments

This unit is assessed using a Pearson Set Assignment Brief. A set assignment must be used to assess learners.

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to IT systems typically found in schools, colleges, and offices such as:

- personal computers
- office productivity applications, for example word processing, databases, spreadsheets
- network connectivity
- internet access.

There are no additional specialist resources needed for this unit.

Learning aim A

For Distinction standard, learners will produce a comprehensive, well-balanced evaluation of how IT infrastructure could be used to meet the needs of an identified organisation and its stakeholders. They will make realistic and well-explained business-related observations on the benefits and disadvantages of the different elements of their infrastructure plan. They will consider the impact on a wide range of the company's stakeholders and the company as a whole.

Learners must articulate their arguments through high-quality written communication, supported by accurate and fluent technical vocabulary. They should use well-structured and considered responses that clearly demonstrate chains of reasoning, leading to concise evaluations and reasoned, valid judgements.

For Merit standard, learners will present a reasoned and well-explained analysis of a range of different ways in which an organisation can use IT infrastructure to meet identified needs.

The analysis will explore the impact the identified methods will have on the organisation and its stakeholders.

The analysis will be balanced and supported by clear examples.

The evidence must be technically accurate and demonstrate good-quality written or oral communication.

For Pass standard, learners will provide a detailed plan of how IT infrastructure could be implemented by an organisation to meet most of its identified needs. The report should cover use of software, hardware and data connections and networks. It will provide some evidence of decision making such as explaining why a particular technology meets an identified need. Learners are unlikely to compare these identified technologies to alternatives.

The evidence may have some inaccuracies and include a limited range of examples.

Learning aims B and C

For Distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims in order to evaluate their recommendations for data and information use, and the policies they have produced.

Learners also need to show that they have considered the impact that the introduction and use of different technologies and procedures will have on the organisation and its stakeholders.

Learners must provide reasoned and realistic justifications of the decisions they have made in their reports and policies. The evaluation and justification will be informed by a balanced, wide-ranging review of the positive and negative aspects of the recommendations they have made in comparison to alternatives.

For Merit standard, learners will provide a clear, accurate and well-reasoned analysis of how and why data and information will be used by the organisation to meet identified needs, considering the importance of data and information to the company and how it will be used. They should consider how data is collected and for what purpose, and how digital tools can help them to use data and information. Learners should also consider how data and information is shared and exchanged between the organisation and its stakeholders (including clients/customers).

Learners will explore the potential threats to the organisation's IT systems and how the mitigation of these threats will impact the organisation.

They will explore how procedures that ensure that IT is used in a legal, moral, ethical and safe manner impact on the organisation and its stakeholders.

Learners will show a clear link to the organisation's requirements.

The analysis will be balanced and supported by clear examples.

The evidence must be technically accurate and demonstrate good-quality written or oral communication.

For Pass standard, learners will produce formal reports that detail how data and information can be used and distributed to meet the identified requirements.

Their formal report will consider the use of data and information, both internally and externally to the organisation.

Learners will produce formal IT policies detailing ways in which the organisation makes use of IT in order to operate in a legal, moral, ethical and safe manner.

The policies will cover potential threats to data, information and the system they use. The policies will provide details of procedures that can be implemented to mitigate potential threats.

Assessment controls

Time: this assignment has a recommended time period. This is for advice only and can be adjusted depending on the needs of learners.

Supervision: you should be confident of the authenticity of learner's work. This may mean that learners be supervised.

Resources: all learners should have access to the same types of resources to complete the assignment.

Research: learners should be given the opportunity to carry out research outside of the learning context if required for the assignment.

Maintaining security

- During any break, materials must be kept securely.
- User areas must be accessible to individual learners and to named members of staff only.
- Access to the internet is not permitted.
- Learners can access their work only under supervision.
- Learner work must be regularly backed up.
- Any work that learners produce under supervision must be kept securely.
- Any materials being used by learners must be collected in at the end of each session, stored securely and handed back at the beginning of the next session.

Links to other units

This unit links to:

- Unit 2: Creating Systems to Manage Information
- Unit 3: Using Social Media in Business
- Unit 5: Data Modelling
- Unit 11: Cyber Security and Incident Management
- Unit 12: IT Technical Support and Management
- Unit 15: Cloud Storage and Collaboration Tools.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems
- ability to work in a legal, moral and ethical manner.

Unit 2: Creating Systems to Manage Information

Level: 3
Unit type: Internal
Guided learning hours: 90

Unit in brief

Learners study the design, creation, testing and evaluation of a relational database system to manage information.

Unit introduction

Relational databases are widely used to manage and process data to support, for example business processes and our social lives. From the smallest in-house systems to stock control systems for large multinational online retailers, databases are repositories of information that are a significant part of organisational operating requirements.

You will examine the structure of data and its origins, and how an efficient data design follows through to an effective and useful database. You will examine a given scenario and develop an effective design solution to produce a database system. You will then test your solution to ensure that it works correctly. Finally, you will evaluate each stage of the development process and the effectiveness of your database solution. To complete the assessment tasks in this unit, you will need to draw on your learning from across your programme.

The skills you gain in this unit support progression to IT-related, higher-education courses and to employment in a role that requires computing-related expertise.

Learning aims

In this unit you will:

A Understand the purpose and structure of relational database management systems

B Design a relational database to meet client requirements

C Develop a relational database to meet client requirements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the purpose and structure of relational database management systems	**A1** Relational database management systems **A2** Manipulating data structures and data in relational databases **A3** Normalisation	Produce a presentation or report evaluating the role of relational database management systems in the decision-making process.
B Design a relational database to meet client requirements	**B1** Relational database design **B2** Design documentation **B3** Evaluation of designs	A practical activity involving the design of a relational database to fulfil client requirements.
C Develop a relational database to meet client requirements	**C1** Producing a database solution **C2** Testing and refining the database solution **C3** Evaluation of testing **C4** Evaluation of the refined database solution	Produce a functional solution including • design documentation • relational database development • testing logs.

Content

Learning aim A: Understand the purpose and structure of relational database management systems

A1 Relational database management systems

Understand relational database management systems and models.

- Types of relational database management systems (RDBMS) and their characteristics.
- RDBMS based on relational models:
  - relational data structures
    - relation, attribute, domain, tuple, cardinality and relational database
  - relational algebra sets
    - symbols, union, intersect, join, select
  - database relations
    - entity relationship, generic, semantic
  - relational keys
    - super key, candidate key, primary key, foreign key
  - integrity constraints
    - entity integrity, referential integrity
  - entity relationships
    - one to one, one to many, many to many.

A2 Manipulating data structures and data in relational databases

Use of RDBMS software tools and structured query language (SQL) for defining, modifying and removing data structures and data:

- Updating, inserting, deletion.
- Retrieval of data for queries, reports.
- Administration of users.
- Security, integrity, recovery.

A3 Normalisation

The role of normalisation to develop efficient data structures:

- Anomalies
  - update, insertion, deletion.
- Primary keys, foreign keys, composite keys.
- Indexing.
- Referential integrity.
- Data dictionary
  - tables, fields, data types, validation.
- Cascading update.
- Deletion techniques.
- Joins, unions, intersects.
- Stages of normalisation
  - un-normalised form (UNF)
  - first normal form (1NF)
  - second normal form (2NF)
  - third normal form (3NF).

Learning aim B: Design a relational database to meet client requirements

B1 Relational database design

Selection of RDBMS and SQL software, tools, techniques and processes.

- Database design: conceptual, logical and physical modelling and entity relationship modelling.
- Relational algebra: one to many, one to one, many to many, AND, OR, NOT, >, <, ≥, ≤.
- RDMS and SQL software selection.
- Application design: user interface, software applications.
- Database implementation techniques:
  - prototyping
  - data conversion
  - testing.
- Quality, effectiveness and appropriateness of the solution:
  - correctness of data
  - relationships between data
  - data integrity
  - normalisation.

B2 Design documentation

The features and characteristics of relational database design techniques and their application to solve problems:

- Requirements of the brief (audience, purpose and client's requirements)
- Security and legal considerations
  - data protection legislation.
- Data structure designs
  - data dictionaries and their use:
    - tables
    - field attributes
    - validation
  - use of naming conventions
  - entity relationship diagrams
  - normalisation.
- User interface design
  - data entry/input:
    - verification
    - validation
    - calculated fields
    - masks
    - directed input
  - reports
    - fields
    - queries
    - presentation of data
    - calculations

    - task automation
        - imports
        - updates
        - deletions.
- Extracting and presenting data
    - queries using multiple criteria, form values and wild cards
    - action queries
    - calculated queries
    - reports
- Design and use of test plans
    - to check correctness of data
    - functionality
    - accessibility
    - usability.

B3 Evaluation of designs

Evaluating a design against given requirements:

- use and application of an entity-relationship diagram, data dictionary, normalisation
- coverage of functionality requirements and identification of any omissions
- identification of design strengths and potential further improvements to meet given requirements.

Learning aim C: Develop a relational database to meet client requirements

C1 Producing a database solution

Select and configure appropriate RDBMS and SQL tools to produce a database solution to meet a client's requirements:

- Creating, setting up and maintaining data tables.
- Creating links, relationships between data tables.
- Applying data validation rules.
- Generating outputs
    - user-generated queries
    - automated queries
    - reports.
- User interface
    - navigation
    - data-entry forms
    - sub-forms.
- Automated functions.
- Populating the database
    - importing
    - adding data
    - manipulating data.
- Devising and using SQL statements to extract, manipulate and modify data.

C2 Testing and refining the database solution

- Test a database solution to meet client needs: different types of testing:
  - referential integrity
  - functionality
  - security.
- Selection and use of appropriate test data:
  - erroneous data
  - extreme data
  - normal data.
- Recording appropriate test documentation.
- Using testing outcomes to improve and refine a database solution.

C3 Evaluation of testing

Evaluating the application of test data to ensure that the database solution meets requirements.

- Different types of testing:
  - normal test data
  - erroneous test data
  - extreme test data.
- Recording of actual results and analysis.
- Commenting on results.
- Test records:
  - completion of test records
  - taking of and storing screenshots of tests.
- Making use of testing outcomes.
- Using iterative processes to improve accuracy, readability and robustness.
- Identifying and recording which tests were successfully met and which test data issues were not resolved.

C4 Evaluation of the refined database solution

Evaluating the software outcome against the given requirements.

- Strengths and weaknesses of the database:
  - solution fitness for purpose
  - intuitiveness and ease of use
  - constraints of the database software used
  - maintainability of the database
  - extent to which database meets the given requirements.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Understand the purpose and structure of relational database management systems		**A.D1** Evaluate how the features and functions of a relational database contribute to a final solution for database management.
A.P1 Explain how the features of a relational database are used for database management.	**A.M1** Analyse how the features of a relational database contribute to a final solution for database management.	
Learning aim B: Design a relational database to meet client requirements		**B.D2** Evaluate the design against client requirements.
B.P2 Produce designs for a relational database that meets client requirements.	**B.M2** Justify design decisions made, showing how the design will fulfil its purpose and client requirements.	
Learning aim C: Develop a relational database to meet client requirements		**C.D3** Evaluate the quality of the testing and the refined database solution.
C.P3 Create and populate a relational database to meet client requirements. **C.P4** Create features in data entry forms to ensure validity and integrity of data. **C.P5** Perform queries using multiple tables and multiple criteria. **C.P6** Use database features and functions to manipulate data within the database. **C.P7** Test the database for correctness, functionality and acceptance.	**C.M3** Import data from an external source. **C.M4** Use advanced features and functions to manipulate data within the database. **C.M5** Implement an automated function **C.M6** Use testing outcomes to improve and refine the database solution.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment*, gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aims: B and C (B.P3, C.P3, C.P4, C.P5, C.P6, C.P7, B.M2, C.M3, C.M4, C.M5, C.M6, B.D2, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to IT systems typically found in schools, colleges, and offices such as:

- personal computers
- office productivity applications, for example word processing, databases, spreadsheets
- network connectivity
- internet access
- hardware and software allowing the function of database resources.

There are no additional specialist resources needed for this unit.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will produce a comprehensive, detailed explanation of how the features of a relational database are used for database management. Learners will evaluate the use of features and functions of relational databases and clearly show how these contribute to a final solution.

Learners' evidence will demonstrate high-quality written/oral communication, through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will produce a detailed explanation of how the features of a relational database are used for database management. Learners will analyse the use of features and functions of relational databases and show how these contribute to a final solution.

The evidence will be technically accurate and demonstrate good-quality written/oral communication.

For Pass standard, learners will produce an explanation of how the features of a relational database are used for database management. Learners will show understanding of features and functions of database software.

The evidence may have some inaccuracies and will make limited use of examples.

Learning aims B and C

For Distinction standard, learners will provide evidence of designing and developing a relational database for a specified scenario that meets client requirements. Learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and processes applied throughout the design, development and testing stages impact on the effectiveness of the final solution.

Learners must produce detailed designs for a relational database. They will develop their final design using a range of appropriate, relational database features and functions. Learners will carry out comprehensive testing to refine and improve their database. They will evaluate the final solution and produce well-considered, justifiable suggestions for future improvements to the database.

Learners will produce an evaluation that is a systematic and accurate review of their own skills and performance, and the impact this had on the effectiveness of the solutions. Creativity will be shown, for example learners will show how they have taken innovative approaches to problem solving and the originality of their solution.

For Merit standard, learners will provide evidence of designing and developing a relational database for a specified scenario that meets client requirements. They will justify how the decisions made and processes applied throughout the design, development and testing stages impact on the effectiveness of the final solution.

Learners will produce detailed designs for a relational database. They must develop their final design using a range of relational database advanced features and functions. They will carry out testing to refine and improve their database. Learners will analyse the final design and provide reasoned justification of how it fulfils its purpose and meets client requirements.

For Pass standard, learners will provide evidence of designing and developing a relational database for a specified scenario that meets client requirements, although some small issues may persist. They will explain how the decisions made and processes applied throughout the design, development and testing stages impact on the effectiveness of the final solution.

Learners will produce designs for a relational database. They must develop their final design using a range of database functions and carry out testing. The results of testing can be used to refine and improve their database. Learners must review the extent to which the final design meets client requirements, although the review may be unbalanced.

Links to other units

This unit links to *Unit 3: Using Social Media in Business*.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop research and presentation skills.

Unit 3: Using Social Media in Business

Level: 3
Unit type: Internal
Guided learning hours: 90

Unit in brief

Learners explore how businesses use social media to promote their products and services internationally. Learners also implement social media activities in a business to meet these demanding requirements.

Unit introduction

Social media websites are a popular way for people to communicate and share information internationally and with friends and family. Around the world people spend a lot of time on social media websites and they give businesses opportunities to interact with people, for example to promote their business internationally, to encourage people to visit their e-commerce site and buy, and to provide customer service. You may be familiar with social media for personal use and in this unit you will discover how it can be used in a business context.

You will explore different social media websites, the ways in which they can be used and the potential pitfalls when using them for business purposes. You will develop a plan to use social media strategies for business purposes to achieve specific aims and objectives. You will then implement the plan, developing and posting content and interacting with others. Finally, you will collect data on the business use of social media and review the effectiveness of your efforts.

Understanding how to use social media for business purposes is useful for employment in information technology and in a variety of business sectors. Also, social media skills are closely linked with web and mobile applications development. This unit gives you a starting point for progression to roles such as social media specialist, content developer and web developer.

Learning aims

In this unit you will:

A Explore the impact of social media on the ways in which businesses promote their products and services

B Develop a plan to use social media in a business to meet requirements

C Implement the use of social media in a business.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the impact of social media on the ways in which businesses promote their products and services	**A1** Social media websites **A2** Business uses of social media **A3** Risks and issues	A report that explores how a business can use social media to raise its profile and promote products and services.
B Develop a plan to use social media in business to meet requirements	**B1** Social media planning processes **B2** Business requirements **B3** Content planning and publishing **B4** Developing an online community **B5** Developing a social media policy **B6** Reviewing and refining plans	Documentation showing the planning, preparation and implementation of the use of social media in a business, which meets identified requirements. Established social media pages dedicated to the business, which fulfil the requirements given in the plan, accompanied by supporting documentation. Statistical data generated by social media websites, including an analysis of how it was used to optimise the use of social media. A report evaluating the use of social media in a business against the plan, showing how well it meets business requirements.
C Implement the use of social media in a business	**C1** Creating accounts and profiles **C2** Content creation and publication **C3** Implementation of an online community building **C4** Data gathering and analysis **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Explore the impact of social media on the ways in which businesses promote their products and services

A1 Social media websites

The use and features of social media websites to support business aims and needs.

- Developments in the use of social media and the ways that businesses promote products and services:
  - social media websites are constantly evolving and new features are introduced regularly
  - features, structure and target audience of different social media websites, e.g. Facebook®, Twitter®, LinkedIn®, Google™ and YouTube™.
- How businesses can use social media websites to support their international business aims and needs, including:
  - creating an image or brand
  - promoting products and/or services
  - communicating with customers
  - customer service
  - resolving queries and managing issues.
- Features of social media websites tailored to business needs, including:
  - advertising
  - linking to previous e-commerce site search history and display of search-related adverts
  - website and mobile device integration
  - relationship to search engine optimisation (SEO)
  - profile on the sites, describing the business to visitors
  - usage data indicating profile of followers and effectiveness of social media posts
  - audience profiles (age, gender, income, location) of social media websites.

A2 International business uses of social media

The use of social media to promote products and services.

- Posting different content formats, e.g. text, images, video, links, polls and quizzes.
- Content focus and meaning, e.g. information, promotion, humour, special offers and customer service.
- Developing an audience and encouraging people to follow or 'like' the business through the creation and use of engaging content.
- Keywords and their use in posted content.
- Developing contacts by following and linking relevant businesses and individuals, and sharing content posted by others.
- Direct and indirect advertising.
- Links to other commercial information, e.g. company website, e-commerce websites.
- Relationship between social media website and company website, e.g. using:
  - social media buttons on the company website
  - company website links within social media posts that encourage visits to e-commerce site to make purchases
  - social media newsfeeds on the company website.

A3 Risks and issues

The risks and issues involved in the use of social media for a business.

- Negative comments on social media sites and damage to reputation.
- Time constraints on social media interaction, return on time investment.
- Unforeseen consequences of posted content.
- Security issues related to increased company profile as a result of use of social media:
  - dangers of virus infection
  - potential for blackmail/ransom
  - theft of company-sensitive information or personal information.

Learning aim B: Develop a plan to use social media in a business to meet requirements

B1 Social media planning processes

The processes to consider when planning the potential use of social media in a business, including:

- the specific business requirements
- content planning and publishing
- developing online communities
- enforcing social media policies.

B2 International business requirements

The identification of international business requirements.

- Working with a client to set requirements for the use of social media and the potential benefits for business when compared to traditional promotion methods.
- Establishing timescales and responsibilities for the use of social media within a business.
- Identifying criteria for measuring the success of the use of social media within a business.
- Selection of social media websites to use by matching site profiles to requirements in terms of the way a business will use social media.
- Identifying targets for the use of social media, number of followers, 'likes' and shares.

B3 Content planning and publishing

The process of planning posts and other content to be published on social media websites, including:

- identifying a target audience (e.g. age, gender, interests, income, location)
- linking type of content to target audience to ensure it is engaging
- researching keywords and creating keyword strategies to help users identify content
- researching the best time to publish content and creating a publishing schedule (type of content, frequency, day and time).

B4 Developing an online community

The concept of working with a client to develop a strategy to encourage online community building, including:

- use of promotional techniques, e.g. requesting feedback, surveys, special offers and creating links between social media websites and company e-commerce site
- monitoring social media website streams and responding to queries, requests and complaints.

B5 Developing a social media policy

The concepts of social media policy. Working with a client to create a social media policy applicable to a business, including:

- company philosophy (identifying and reflecting this in posted content)
- promotion of honesty and respect in posted content
- ways to ensure confidentiality of information
- methods of dealing with security issues
- separation of company and personal content
- relevant legal and ethical considerations.

B6 Reviewing and refining plans

The implications of working with a client to improve the quality, effectiveness and appropriateness of the plans. Working with a client and other relevant stakeholders to improve the quality, effectiveness and appropriateness of the plans, including:

- gathering feedback from a client and potential users
- communicating with a client, e.g. email, verbal communication
- scheduling and documenting meetings
- agreeing and adjusting timescales
- refining ideas and solutions.

Learning aim C: Implement the use of social media in a business

C1 Creating accounts and profiles

The concepts of creating accounts and profiles when implementing a plan.

- Sign-up, creation and administration of social media website business accounts.
- Creation and set-up of a company profile.
- Customisation and configuration of the company profile, including privacy settings, colour schemes, images, text and other assets that follow branding guidelines.

C2 Content creation and publication

The use of appropriate social media website tools and techniques to implement a plan.

- Carry out research in order to produce engaging content for the intended target audience.
- Produce, publish and manage content.
- Improve visibility of published content.
- Methods to encourage audience interaction, e.g. use of images, phrasing of text content, timing of posts to coincide with times when followers are online.

- Integration of information across e-commerce website and social media websites.
- Adapting and testing content on different device platforms, e.g. mobile phones, tablets and notebooks.

C3 Implementation of building an online community

Implementation and monitoring of an online community strategy using tools and techniques.

- Implementation of building an online community strategy, including:
  - use of hashtags, sharing and tagging
  - finding and joining groups and contributing information
  - following people and businesses.
- Monitoring and responding to comments; importance of prompt responses.
- Using tools and techniques to automate content posting.

C4 Data gathering and analysis

The concepts and implications of interpreting data on social media websites.

Gathering and interpreting data on social media websites using dedicated tools.

- Identifying interaction relating to individual posts.
- Identifying audience profiles, e.g. age, location.
- Monitoring number of 'likes' and 'shares'.
- Comparison of intended target audience versus actual audience.
- Identification of posts and types of content that create the highest levels of interaction.
- Identifying the number of visitors who 'click through' to company e-commerce website.

C5 Skills, knowledge and behaviours

The skills, knowledge, and behaviours required when implementing social media.

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others, such as customers and social media followers, will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. customers and social media followers who can provide feedback on the quality and suitability of the features against the business requirements.
- Demonstrating own behaviours and their impact on outcomes, to include professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.

- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use); verbal communication requirements (one-to-one and group informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectations, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Explore the impact of social media on the ways in which businesses promote their products and services</td><td rowspan="2">A.D1 Evaluate the business use of social media to interact with customers and promote products or services to a target audience.</td></tr>
<tr><td>A.P1 Explain the different ways in which a business can use social media.
A.P2 Explain the audience profiles of different social media websites.</td><td>A.M1 Assess the different ways in which a business can use social media to attract a target audience.</td></tr>
<tr><td colspan="2">Learning aim B: Develop a plan to use social media in a business to meet requirements</td><td rowspan="3">BC.D2 Evaluate the plan and use of social media in a business against business requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the planning and use of social media in a business context.</td></tr>
<tr><td>B.P3 Produce a plan to use social media in a business to meet its business requirements.
B.P4 Review the plan with others in order to identify and inform improvements.</td><td>B.M2 Justify planning decisions made, showing how the plan will fulfil its purpose and business requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Implement the use of social media in a business</td></tr>
<tr><td>C.P5 Produce business-related content using appropriate features of social media which meet the requirements of the plan.
C.P6 Review data obtained on social media usage and interaction.</td><td>C.M3 Optimise the content, format and features of social media which meet the requirements of the plan.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment*, gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to a variety of social media websites that will allow them to plan and implement the use of the social media features.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will produce a comprehensive, well-balanced evaluation of how a business uses social media, making realistic and well-explained business-related observations on the benefits and disadvantages, while considering their target customers or audience. Learners will provide real-life, relevant examples of how businesses have used social media effectively and how some businesses have not managed the risks involved effectively. Learners must articulate their arguments fluently and their views concisely, providing an evaluation that makes reasoned, valid judgements.

The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary, to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will present a reasoned and well-explained assessment of a range of different ways that a business can use social media to interact with the target audience for their products and/or services. The discussion will be balanced and supported by clear examples. Learners will focus their comments on the business uses of the sites and not personal uses. The evidence must be technically accurate and demonstrate good-quality written or oral communication.

For Pass standard, learners will provide detailed information, supported by real-life examples, covering all the ways that businesses can use social media (as listed in the unit content). They will research the different audience profiles for the main social media sites, explain how the different sites appeal to their different audiences and relate it to how different businesses can use social media. The evidence may have some inaccuracies and include a limited range of examples.

Learning aims B and C

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims in order to evaluate both the plan to use social media and its implementation. Learners must provide a reasoned and realistic review of the outcomes, identifying both the positive and negative aspects. For example, they can explain why some things they planned to do did not happen or did not work out as they had expected. Learners also need to show that they have considered the local legal and ethical implications of the material that they posted on social media sites. Learners will make reasoned, appropriate suggestions as to how the use of social media could be improved in the future. They will undertake a detailed examination of the data collected on the interaction achieved and the profile of the people who have interacted with their social media posts. This information will link clearly to a discussion of how well the data matches their intentions. For example, learners may discover that the age and location profile of the people interacting with their posts does not match the target audience of the business concerned. In this case, they would need to discuss possible reasons for the mismatch and how this issue could be resolved.

Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through evidence of taking innovative approaches to problem solving and the originality of their solution. The evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as liaising with clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they had on the outcomes. Learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For Merit standard, learners will provide a clear, accurate and well-reasoned justification of the choices they made in the planning of the use of social media. Learners will show a clear link to the required business objectives. Learners also need to show that they have considered the local legal and ethical implications of the material that they posted on social media sites. The usage data collected by learners will also assess how effective each of their posts has been at achieving their stated aim and how effective it has been in encouraging interaction with the audience. Learners will apply their knowledge through selection and application of appropriate tools and techniques to optimise the effectiveness of their future posts and other social media features. They will make accurate and reasoned suggestions as to how the outcomes could be improved if the task were to be repeated.

For Pass standard, learners will produce a plan that meets the business requirements and identifies the target audience. The plan will also identify timescales and keywords, and include a content-posting schedule. Learners will show an awareness of local legal and ethical implications of the content they plan to post.

Learners will review their plan, and ask others such as the client/employer and customers/audience to assist them in this process and provide evidence of their review.

Learners will select a variety of social media websites and implement their plan and interact with their followers. Some simulation may be required in order to provide the interaction and fellow learners can play the role of 'customers' for each other. Learners can provide evidence in the form of annotated screenshots showing how they have implemented the plan they have created.

Learners must collect and review a range of data using features such as Facebook Insights, Google Analytics and Twitter Analytics, showing the interaction that individual posts have created and the profile of their audience. This data will be used to optimise their future posts, for example by adjusting the wording, content and timing of posts, as well as demonstrating use of any other new features.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 4: Programming
- Unit 9: IT Project Management
- Unit 11: Cyber Security and Incident Management.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop social media
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 4: Programming

Level: 3
Unit type: Internal
Guided learning hours: 90

Unit in brief

Learners study the underpinning concepts and implications of programming languages to design, develop and test computer programs.

Unit introduction

Organisations and individuals increasingly depend on the functions and services offered by computing devices such as smartphones, tablets, laptops and personal desktop computers. You make use of computing programs when using an operating system or application programs such as word processing and spreadsheets. Understanding the concepts of high-quality software application design and development is key to ensuring that products are effective. As a programmer, you will need to understand the characteristics of different programming languages in order to select and apply appropriate methodologies to meet a client's needs.

Many organisations and businesses rely on computer programs to help deliver products and services. Organisations and businesses (often known as 'clients') work closely with programmers to help design and build computer programs that fulfil their requirements. To complete the assessment task within this unit, you will need to draw on your learning from across your programme of study and apply programming skills to provide a solution for a new IT-related problem.

You will learn about computational thinking skills and the principles of designing and developing computer programs. You will apply computational thinking skills to design, develop, test, refine and review computer programs for a given range of purposes. By developing your analytical, problem-solving and programming skills, this unit will help you to progress to higher education or to employment as a software developer.

Learning aims

In this unit you will:

A Examine the computational thinking skills and principles of computer programming

B Design a software solution to meet client requirements

C Develop a software solution to meet client requirements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Examine the computational thinking skills and principles of computer programming	**A1** Computational thinking skills **A2** Uses of software applications **A3** Features and characteristics of programming languages **A4** Constructs and techniques and their implementation in different languages **A5** Principles of logic applied to program design **A6** Quality of software applications	A report evaluating computational thinking skills and how the principles of software design and computer programming are applied to create effective, high-quality software applications.
B Design a software solution to meet client requirements	**B1** Software development life cycle **B2** Software solutions design	A project brief identifying the scope of the problem and user/client requirements. Design documentation for the suggested solution. User feedback and design refinement documentation. Development and support documentation, including development and testing logs, meeting notes and a report that evaluates the outcomes and development of the project.
C Develop a software solution to meet client requirements	**C1** Software solutions development **C2** Testing software solutions **C3** Improvement, refinement and optimisation of software applications **C4** Review of software solutions **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Examine the computational thinking skills and principles of computer programming

A1 Computational thinking skills

Application of computational thinking skills needed to analyse problems and processes in order to identify solutions that can be developed into software applications.

- Decomposition:
  - identifying and describing problems and processes
  - breaking down problems and processes into distinct steps
  - describing problems and processes as a set of structured steps
  - communicating the key features of problems and processes to others as relevant.
- Pattern recognition:
  - identifying common elements or features in problems or systems
  - identifying and interpreting common differences between processes or problems
  - identifying individual elements within problems
  - describing patterns that have been identified
  - making predictions based on identified patterns.
- Pattern generalisation and abstraction:
  - identifying information required to solve an identified problem
  - filtering out information required to solve an identified problem.
- Representing parts of a problem or system in general terms by identifying:
  - variables
  - constants
  - key processes
  - repeated processes
  - inputs
  - outputs.

A2 Uses of software applications

The uses and implications of software applications in solving problems and fulfilling needs, including:

- gaming and entertainment
- productivity
- information storage and management
- repetitive tasks or dangerous tasks
- social media
- search engines.

A3 Features and characteristics of programming languages

The uses and applications of different types of high- and low-level programming languages, developed to assist in the solution of particular problems, such as:

- procedural, e.g. C, Perl, Python
- object-orientated, e.g. C++, C#, Java
- event-driven, e.g. Visual Basic®
- machine, e.g. Assembler
- mark-up, e.g. HTML.
- Factors to compare and contrast in programming languages, including:
  - hardware and software needed for running and developing a program
  - special devices required
  - performance
  - preferred application areas
  - development time
  - ease of development.

A4 Constructs and techniques and their implementation in different languages

The constructs and techniques involved in the use of programming languages.

- Programming languages, constructs and techniques, including:
  - command words
  - constants and variables, local and global variables
  - data types – character, string, integer, real, Boolean
  - statements – assignment, input and output, sequence, iteration, selection
  - logical operations.
- Other constructs, such as:
  - subroutines, functions and procedures
  - string handling, including examining single characters and substrings
  - arrays – two-dimensional and three-dimensional, splitting and joining
  - file handling – open, read, write, close, database
  - data structures
  - event handling.
- Documentation of code.

A5 Principles of logic applied to program design

The concepts of applying logic to program design.

Principles, including:

- iteration – repetition of a computational procedure applied to the result of a previous application
- mathematical logic – inference, consistency, completeness, verification by truth tables
- propositional dynamic logic to demonstrate the function of algorithms
- use of sets, e.g. properties and interrelationships of sets of data, search/filter sets of data.

A6 Quality of software applications

How the design and implementation of a software application affects quality, including:

- efficiency/performance, e.g. the system resources consumed by the program, CPU cycles, processor time, memory space, accessing storage media
- maintainability, e.g. ease with which a program can be modified by its present or future developer in order to carry out corrective, perfective or adaptive maintenance
- portability, e.g. range of computer hardware, operating systems and platforms on which the source code can be run/compiled/interpreted
- reliability, e.g. accuracy and the consistency of its outputs
- robustness, e.g. quality of coding and testing to ensure that extreme and erroneous data can be processed without causing the program to crash
- usability, e.g. ease with which an end user can use the program.

Learning aim B: Design a software solution to meet client requirements

B1 Software development life cycle

Application of the software development life-cycle stages, including:

- assessment of the requirements for an identified problem
- design specification, e.g. scope, inputs/outputs, user interface, timescales
- develop code
- implementation
- test, e.g. white box and black box testing, refinement, optimisation
- maintenance, e.g. corrective, adaptive and increased functionality.

B2 Software solutions design

The concepts and implication of the use of software solutions design.

- Problem definition statements, to include: intended users, full summary of the problem to be solved, constraints, benefits, nature of interactivity, complexity of problem.
- Purpose and any other requirements as defined in a client brief.
- Features of software:
  - description of main program tasks, input and output formats
  - diagrammatic illustrations, to include screen layouts, user interfaces, navigation
  - algorithms and processing stages, to include flow charts, pseudocode and events
  - data structures
  - data storage
  - control structures
  - data validation
  - error handling and reporting.
- Choice of language.
- List of predefined programs and/or code snippets.
- List of ready-made and/or original assets such as a digital animation, digital graphic, digital audio and video.
- Feedback from others to help refine alternative design ideas/prototypes and make decisions.
- Test plan with test data to include typical, extreme and erroneous data.
- Technical and design constraints, e.g. connectivity, memory storage, programming languages.

Learning aim C: Develop a software solution to meet client requirements

C1 Software solutions development

The concepts and processes of the software solutions development process.

The process of software development, including:

- the development environment to produce code
- the development and refinement of software programs using a suitable programming language
- library routines, standard code and user-generated subroutines used to add to the efficiency of a program.

C2 Testing software solutions

The concepts of the testing processes used for software solutions.

Testing of the programs, including:

- test plan
- test data – typical, extreme and erroneous data
- selection and use of appropriate types of testing to test part or all of a program, e.g. functional testing, stability, compatibility.

C3 Improvement, refinement and optimisation of software applications

The methods and processes used to improve and optimise software applications.

Methods of improving, refining and optimising, e.g.:

- annotated code to allow effective repair/debugging of the program and maintainability
- program compilation for a designated platform or environment
- review – quality of a program in terms of reliability, usability, efficiency/performance, maintainability, portability
- eliciting feedback from users
- making use of the outcomes of testing and feedback
- documenting changes to the design and solution.

C4 Review of software solutions

The concepts and evaluation of software solutions.

Evaluation of software solutions, including:

- suitability for audience and purpose
- ease of use
- quality of the software solution, e.g. reliability, usability, efficiency/performance, maintainability, portability
- constraints of the programming language
- other constraints, e.g. time, programmer knowledge, rules of languages vary with implementation
- strengths and weaknesses of the software solutions
- improvements that can be made
- optimising software solutions, e.g. improving robustness, improving efficiency of the code, adding additional functionality.

C5 Skills, knowledge and behaviours

The skills, knowledge, and behaviours required when implementing software solutions.

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the program and its suitability when assessed against the original requirements.
- Demonstrating own behaviours and their impact on outcomes, to include professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
    - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use); verbal communication requirements (one-to-one and group informal and formal situations)
    - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on the audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, and avoidance of jargon
    - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectations and resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Examine the computational thinking skills and principles of computer programming		
A.P1 Explain how computational thinking skills are applied in finding solutions that can be interpreted into software applications. **A.P2** Explain how principles of computer programming are applied in different languages to produce software applications. **A.P3** Explain how the principles of software design are used to produce high-quality software applications that meet the needs of users.	**A.M1** Analyse how computational thinking skills can impact software design and the quality of the software applications produced.	**A.D1** Evaluate how computational thinking skills can impact software design and the quality of the software applications produced.
Learning aim B: Design a software solution to meet client requirements		
B.P4 Produce a design for a computer program to meet client requirements. **B.P5** Review the design with others to identify and inform improvements to the proposed solution.	**B.M2** Justify design decisions, showing how the design will result in an effective solution.	**BC.D2** Evaluate the design and optimised computer program against client requirements. **BC.D3** Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of the computer program.
Learning aim C: Develop a software solution to meet client requirements		
C.P6 Produce a computer program that meets client requirements. **C.P7** Review the extent to which the computer program meets client requirements.	**C.M3** Optimise the computer program to meet client requirements.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment*, gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.P3, A.M1, A.D1)

Learning aims: B and C (B.P4, B.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to a range of programming languages, IDEs (integrated development environment) and diagramming tools to allow them to use a variety of tools and techniques (given in the unit content) to design and develop computer programs.

Learners will need access to examples of programs and code bases written in a range of languages for a number of different purposes. While access to the code base of many proprietary applications is restricted, there are many open-source alternatives that can be used.

Essential information for assessment decisions

Learning aim A

Evidence for this assignment will be in the form of a written response that investigates computational thinking skills and the principles and purpose of different programming languages. The report will make use of specific examples of code implementation (and the chosen paradigm) to explore how the example code has been implemented to meet specific needs.

The code base used by learners in their investigation must be of sufficient complexity to allow analysis of the implementation of a range of programming constructs, including standard and language-specific techniques, logical structures and mathematical principles.

For Distinction standard, learners will provide an evaluation of how computational thinking skills are used to find solutions to problems and how this can impact software design and the applications developed. They will provide a clear and balanced evaluation of the use of different programming languages (in identified programs) to solve different, specific problems. Learners will provide a detailed analysis of the programming principles used in the identified programmes. They will evaluate the success of their implementation in terms of the quality of code produced, and in a wider context where applicable. Quality will be considered in terms of the degree to which user requirements are met, the robustness of the code, its maintainability, efficiency, portability and ease of use.

Learners will provide an evaluation of the identified programming languages. They will consider the principles they have analysed and explain why specific programming languages are used and what advantages they may offer to the programmer and the end user.

Learners must articulate their arguments and views fluently and concisely, providing an evaluation that makes reasoned and valid judgements. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will analyse how computational thinking skills can impact software design, highlighting features of decomposition, pattern recognition and pattern generalisation and abstraction. Learners will show a clear understanding of how different programming languages are implemented to solve problems. They will provide a balanced and reasoned analysis of the strengths and weaknesses of the identified

code in solving the problems and the quality of the implementations. They will analyse the strengths and weaknesses of the identified languages and how they affect the requirements of the user and the development of a program to meet defined needs. The evidence will be technically accurate and demonstrate good-quality written or oral communication.

For Pass standard, learners will explain how computational thinking skills are used to find solutions to problems. They will explain the range of programming languages available, as given in the unit content. Learners will explain how each differs in terms of constructs, techniques, use and requirements. They must choose one example program that has been created to solve a particular problem/meet a specific need, and provide descriptions of how programming constructs and the principles of software design have been applied to develop a solution to meet the required needs of users. Learners will also consider how computational thinking skills may have been applied when exploring the principles of software design. They will explain how different software design methods can be used to produce effective applications. This can be achieved by using supporting examples. The evidence may have some inaccuracies and may include limited use of examples to illustrate the explanations.

Learning aims B and C

Learners must develop a program to solve a specific problem. The problem must be of significant complexity to allow learners to demonstrate the application of a range of appropriate problem solving and programming skills.

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims to produce a detailed evaluation of the planning, development and refinement of the solutions in line with client requirements. They must explain methodologies applied throughout the process and justify their use in ensuring the requirements of the client are met.

Learners must provide a thorough evaluation of the effectiveness of the final program, including a systematic evaluation of the techniques, principles and constructs applied in their program. They will provide well-considered, justifiable suggestions for future improvements to the program.

Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners must refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For Merit standard, learners will apply their knowledge through the selection and application of appropriate methodologies to plan, develop and test an effective, optimised computer program. Learners will use feedback from others to identify how their design could be improved and produce a solution design.

Learners must provide a clear, accurate and well-reasoned justification for the decisions made throughout the development of the program, linking decisions to their effectiveness in meeting user requirements. In doing this, learners will optimise the effectiveness and efficiency of their solution in line with the user requirements. They will take feedback from others into account and explain how they decided to accept or reject recommendations.

Learners must optimise their computer program by making use of testing and feedback throughout development to improve and refine their code to fully meet client requirements, for example improving data validation procedures, the efficiency of the code or the usability of the program.

For Pass standard, learners will apply their understanding of the software development life cycle to design and develop a computer program to meet identified requirements. Learners must apply an understanding of client requirements and provide planning documentation that demonstrate the possible solutions to the identified problems. They will seek feedback on their design and use this feedback to improve the quality of their design solution for the problem.

Learners must produce evidence that the finished program has been tested using a number of different appropriate testing methods to ensure they are functional. They must produce solutions that meet the requirements of the client; however some small issues may persist.

Learners must provide a review of whether their work meets client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. They will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 3: Using Social Media in Business
- Unit 5: Data Modelling
- Unit 7: Mobile Apps Development
- Unit 8: Computer Games Development.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop software solutions
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 5: Data Modelling

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners study how data modelling can be used to solve problems. They will design and implement a data model to meet client requirements.

Unit introduction

In all aspects of life, individuals are constantly faced with situations where they must weigh up the available information in order to produce alternatives and make decisions. In a working environment, effective decision making can ensure the successful development of organisations. Poor decision making can have significant negative consequences and can even lead to the demise of an organisation.

In this unit, you will investigate the fundamentals of the decision-making process. You will find out how using data modelling provides the computational ability to compare consequences, and determine a preferred course of action. You will develop the skills and techniques necessary to create complex spreadsheets in order to produce accurate information that informs decision making. You will examine a scenario and then design, develop and test a spreadsheet; you will review your spreadsheet and make refinements based on user feedback, providing an evaluation of the effectiveness of the alternatives produced.

The skills developed in this unit are useful for progression to computing or business-related higher education courses and for use in decision making in the workplace.

Learning aims

In this unit you will:

A Investigate data modelling and how it can be used in the decision-making process

B Design a data model to meet client requirements

C Develop a data model to meet client requirements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate data modelling and how it can be used in the decision-making process	**A1** Stages in the decision-making process **A2** Spreadsheet features used to support data modelling **A3** Using data modelling to consider alternatives **A4** Evaluating models **A5** Documenting and justifying decisions	A presentation or report evaluating the role of data modelling in the decision-making process.
B Design a data model to meet client requirements	**B1** Functional specification **B2** Spreadsheet model design **B3** Reviewing and refining data model designs	A practical activity, involving the design and development of a data model to fulfil identified client requirements. A functional specification, design documentation, spreadsheet development and testing logs. A report that evaluates the effectiveness of the alternatives considered, and suggests ways in which the alternatives could be improved if the task were to be repeated.
C Develop a data model to meet client requirements	**C1** Developing a data model solution **C2** Testing the data model solution **C3** Reviewing and refining the data model solution **C4** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate data modelling and how it can be used in the decision-making process

A1 Stages in the decision-making process

The concepts and challenges at each stage of the decision-making process.

- Understanding the scenario.
- Identifying information and sources:
  - information required
  - information that is already available
  - additional information needed
  - sources of additional information
  - requirements for verifying the information sources.
- Factors affecting the quality of information:
  - currency of data
  - accuracy of data
  - external factors.
- Analysing the information.
- Identifying alternatives.
- Identifying consequences of implementing the alternatives.
- Making a decision.
- Justifying the decision.
- Communicating decision(s) to others (e.g. client, supervisor, project sponsor), as appropriate.

A2 Spreadsheet features used to support data modelling

The use of spreadsheet features and functions to support data modelling.

- Entering and editing data.
- Formatting data.
- Using formulae and functions.
- Validation (and verification) of data.
- Analysing and interpreting data.
- Presenting data.

A3 Using data modelling to consider alternatives

The use of data modelling to consider the benefits and limitations of alternative solutions.

- Identifying the inputs required for the model.
- The range of outputs that can be produced.
- Benefits and limitations of alternative solutions.
- Impact/consequences of alternative solutions.
- Identifying the alternative solution(s) that produce the best decision or compromise.

A4 Evaluating models

The concepts of evaluating models in the decision-making process.

The factors to consider in the evaluation of the model:

- how well the model reflects the scenario being modelled
- the decisions that can be made, using the model
- whether the model can be improved
- whether or not there are other factors that could be used to extend the model.

A5 Documenting and justifying decisions

The requirements for documenting and justifying the model:

- summarising the situation
- identifying information sources used
- indicating the factors considered
- indicating the method used to reach a decision
- justifying the choice of information sources, factors considered and methods used.

Learning aim B: Design a data model to meet client requirements

B1 Functional specification

The concepts and processes of a functional specification.

Designing a functional specification to meet requirements:

- nature of the problem
- functions the model must perform
- user interface
- constraints
- success criteria.

B2 Spreadsheet model design

The uses and requirements of spreadsheet model design.

A design that shows how the spreadsheet model will look and work.

- Producing worksheet structure diagrams that show:
  - layout and presentation
  - processing
  - data entry and validation
  - navigation
  - output.
- Producing a test plan to show:
  - test data
  - purpose of the test
  - expected result.

B3 Reviewing and refining data model designs

The implications of working with a client to improve the quality, effectiveness and appropriateness of the designs.

Working with clients and others to improve the quality, effectiveness and appropriateness of designs.

- Gathering feedback from client(s) and potential users on the extent to which the design meets requirements.
- Communicating with clients, e.g. email, verbal communication.
- Scheduling and documenting meetings.
- Agreeing and adjusting timescales.
- Refining ideas and solutions.
- Updating design specification documentation, based on review and feedback.

Learning aim C: Develop a data model to meet client requirements

C1 Developing a data model solution

The concepts and processes of the data model development process.

- Processing features and requirements:
  - formulae, e.g. add, subtract, divide, multiply
  - functions, e.g. SUM, AVERAGE, COUNT, COUNTIF, LOOKUP, INDEX, GOAL SEEK
  - logical functions, e.g. IF, NOT, AND, OR, WHATIF
  - nested IF functions
  - data manipulation, e.g. sorting, grouping, filtering, pivoting data
  - importing and exporting data
  - autofill
  - replication
  - relative and absolute cell referencing
  - using macros and buttons to initiate procedures.
- Data entry and validation requirements and methods:
  - use of data-entry forms
  - restricting data input to acceptable values
  - protecting cells by hiding, locking and password protecting
  - ease of use techniques, e.g. list boxes and drop-down menus
  - automated data transfer between sheets or applications
  - adding user prompts and messages.
- Layout and presentation considerations:
  - font size and style
  - merging cells
  - colours, borders, shading
  - conditional formatting
  - headers and footers
  - graphics.

- Output requirements:
  - worksheet layout
  - graphics
  - colours, borders and shading
  - charts and graphs.

C2 Testing the data model solution

The application of formative and summative testing to test data models, including functionality and acceptance.

- Testing to establish whether:
  - the solution meets all of the requirements of the functional specification
  - the underlying logic of the model is correct
  - all the functions and formulae work correctly.
- Other factors to consider:
  - selection and use of appropriate test data, e.g. valid, invalid, erroneous, extreme
  - selecting suitable users for solution testing
  - gathering feedback from users, e.g. effectiveness, presentation, performance and purpose
  - designing and completing test documentation.

C3 Reviewing and refining the data model solution

Understand the concepts of making improvements and/or refinements to the model in order to meet client requirements.

- Refining the model to take account of issues raised during testing.
- Refining the model to take account of the feedback and client requirements.
- Factors that could be used to extend the model.

C4 Skills, knowledge and behaviours

The skills, knowledge and behaviours required when implementing a data model solution.

- Planning and recording, including setting relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. professionals who can provide feedback on the quality of the data model and its suitability against the design requirements.
- Demonstrate own behaviours and their impact on outcomes, to include professionalism, etiquette, support of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.

- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use); verbal communication requirements (one-to-one and group informal and formal situations)
  - use of tone and language for verbal and written communications, to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectations, resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Investigate data modelling and how it can be used in the decision-making process		**A.D1** Evaluate how the features of spreadsheet software contribute to the decision-making process.
A.P1 Explain the stages involved in the decision-making process for data modelling. **A.P2** Explain how the features of spreadsheet software are used to support the decision-making process.	**A.M1** Analyse how the features of spreadsheet software contribute to the decision-making process.	
Learning aim B: Design a data model to meet client requirements		**BC.D2** Evaluate the design and optimised data model against client requirements. **BC.D3** Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of a data model.
B.P3 Produce designs for a data model which meet client requirements. **B.P4** Review the designs with others, to identify and inform improvements.	**B.M2** Justify decisions made, showing how the design will fulfil its purpose and client requirements.	
Learning aim C: Develop a data model to meet client requirements		
C.P5 Develop a data model to meet client requirements. **C.P6** Test the data model for correctness, functionality and acceptance. **C.P7** Review the extent to which the data model meets client requirements.	**C.M3** Optimise the data model to meet client requirements.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use the features and functions of spreadsheet software, as given in the unit content, to design and develop data models.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will produce a comprehensive, detailed explanation of the stages involved in the decision-making process, considering how a systematic approach using valid information leads to informed decisions that can be justified. Learners will evaluate the use of advanced features and functions of a spreadsheet in data modelling, and clearly show how this contributes to the decision-making process.

Learners' evidence will demonstrate high-quality written/oral communication, through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will produce a detailed explanation of the stages involved in the decision-making process and show clear understanding of how a systematic approach using valid information leads to informed decisions. Learners will analyse how advanced features and functions of spreadsheet software in data modelling can contribute to the decision-making process.

The evidence will be technically accurate and demonstrate good-quality written/oral communication.

For Pass standard, learners will produce an explanation of the stages involved in the decision-making process, and show understanding of how a systematic approach using valid information leads to informed decisions. Learners will show understanding of advanced features and functions of spreadsheet software in data modelling. The evidence may have some inaccuracies and make limited use of examples.

Learning aims B and C

For Distinction standard, learners will provide evidence of designing and developing a data model for a specified scenario that meets client requirements. Learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and processes applied throughout the design, development and testing stages impact on the effectiveness of the final solution.

Learners must produce detailed designs for a data model, which will include a range of alternative solutions. Learners will evaluate the alternatives and their impact and consequences, selecting, and justifying the selection of the alternative(s) that produce the best decision or compromise. Learners will develop their final design using a range of appropriate, advanced spreadsheet features and functions. They will carry out comprehensive testing and seek user feedback, which will be used to refine and improve their data model. They will evaluate the final design and produce well-considered, justifiable suggestions for future improvements to the data model.

Learners will produce an evaluation that is a systematic and accurate review of their own skills and performance and the impact that this had on the effectiveness of the solutions. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example by evidence of taking innovative approaches to problem solving, and the originality of their solution.

For Merit standard, learners will provide evidence of designing and developing a data model for a specified scenario that meets client requirements. They will justify how the decisions made and processes applied throughout the design, development and testing stages impact on the effectiveness of the final solution.

Learners will produce detailed designs for a data model that will include a range of alternative solutions. Learners will analyse the alternatives and their impact, selecting the alternative(s) that produce the best solution. Learners must develop their final design using a range of advanced spreadsheet features and functions. They will carry out testing and seek user feedback, which will be used to refine and improve their data model. Learners will analyse the final design and provide reasoned justification of how it fulfils its purpose and meets client requirements.

For Pass standard, learners will provide evidence of designing and developing a data model for a specified scenario that meets client requirements, although some small issues may persist. They will explain how the decisions made and processes applied throughout the design, development and testing stages impact on the effectiveness of the final solution.

Learners will produce designs for a data model that will include a range of alternative solutions. Learners will consider the alternatives and their impact, selecting the alternative(s) that produce the best solution. Learners must develop their final design using a range of spreadsheet functions, carry out testing and seek user feedback. The results of testing and user feedback can be used to refine and improve their data model. Learners must review the extent to which the final design meets client requirements, although the review may be unbalanced.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 6: Website Development
- Unit 11: Cyber Security and Incident Management
- Unit 12: IT Technical Support and Management
- Unit 14: Customising and Integrating Applications
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 20: Business Process Modelling Tools.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop a data model solution
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 6: Website Development

Level: 3
Unit type: Internal set assignment
Guided learning hours: 60

Unit in brief

Learners investigate website development principles. They will design and develop a website using scripting languages.

Unit introduction

Increasingly, international organisations rely on websites to serve customers and, in some cases, to generate revenue. With millions of web pages being created daily, the need for websites to be engaging, innovative and desirable is important. As a website developer, you must use sophisticated techniques to capture user interest and to ensure that customers are served. The scripting involved in the development of websites has become crucial: website developers need to understand and acquire the necessary skills to find solutions to a variety of scenarios and problems.

In this unit, you will review existing websites – commenting on their overall design and effectiveness. You will use scripting languages such as Hypertext Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript® and a simple text editor, or rapid application development tools. Finally, you will reflect on the website design and functionality using a testing and review process.

Many software developers, database experts and systems managers need web-client development skills as an integral part of their overall portfolio of expertise. This unit will prepare you for employment as a website developer or as a website development apprenticeship. The unit will benefit you if you want to go on to higher education to develop your studies.

Assessment

This unit has a set assignment. Learners must complete a Pearson Set Assignment Brief.

Learning aims

In this unit you will:

A Understand the principles of website development

B Design a website to meet client requirements

C Develop a website to meet client requirements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the principles of website development	**A1** Purpose and principles of website products **A2** Factors affecting website performance	This unit is assessed through a Pearson Set Assignment.
B Design a website to meet client requirements	**B1** Website design **B2** Common tools and techniques used to produce websites	
C Develop a website to meet client requirements	**C1** Client-side scripting languages **C2** Website development **C3** Website review **C4** Website optimisation **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Understand the principles of website development

A1 Purpose and principles of website products

The concepts and principles of website production.

- Purpose of websites, including the features of:
  - content-based (Web 2.0 technologies)
  - product and/or service-based
  - target audience, e.g. social networker, seekers, gamers, buyers, age profile, gender
  - requirements, e.g. user-friendly, consistent, navigational, customisable, flexible.
- Principles of website design, e.g. usability, white space, site layout, accessibility, spacing, navigation, typography, alignment, clarity, consistency/intuitiveness, accuracy, content, media, simplicity.
- Media and objects, e.g. position, colour, contrast, size, appropriateness.
- Creativity and innovation, e.g. unconventional layouts, white space, 'outside of the box' thinking, golden ratio.
- Search engine optimisation, e.g. indexing (meta tags), use of keywords, importance of updates, limiting crawling.

A2 Factors affecting website performance

Requirements of website performance to support organisational requirements.

- Where scripts run (on the web server – server-side scripts, or the local client machine – client-side scripts).
- Browser compliance, e.g. which elements are supported by different browsers.
- Server-side factors, e.g. bandwidth availability, number of hits, file types.
- Client-side factors, e.g. upload and download speeds, browser, cache memory, processor speed, interactivity.

Learning aim B: Design a website to meet client requirements

B1 Website design

Website design requirements driven by the priorities of an organisation.

Understanding the steps involved in developing a design for a client website.

- Problem definition statement requirements: intended audience, full summary of the problem to be solved, constraints, benefits, nature of interactivity, complexity of the website.
- Purpose requirements as defined in a client brief for their interactive website.
- Application of website design principles by professionally created websites.
- Initial design ideas/prototypes (illustrating design principles) and the requirements for an interactive website, including:
  - diagrammatic illustrations, e.g. storyboard, mood board, wireframe, site maps
  - realistic representations
  - search engine optimisation
  - alternative design ideas/prototypes, including compatibility with mobile/tablet devices.

- Client-side scripting design tools and techniques, e.g. pseudocode, flow charts (including use of British Computer Society (BCS) standard flow chart symbols) used to develop original code.
- Effective use of ready-made and/or original assets, e.g. a digital animation, digital graphic, digital audio and video, or any other combined assets.
- Obtaining and using feedback from others to help refine alternative design ideas/prototypes and make decisions.
- Testing plan requirements and its completion with test data, to test functionality.
- Identifying technical and design constraints and working around them.
- Local legal and ethical considerations applicable.

B2 Common tools and techniques used to produce websites

Use of tools and techniques and their suitability for different client requirements.

- HTML, HTML5 and subsequent updates.
- Tables.
- Forms, text field, text area, buttons, radio buttons, check boxes.
- Navigation, menus, hyperlinks (internal and external), anchors.
- Interactive components, e.g. hot spots, pop-ups, buttons, menus, rollover images.
- Colour schemes, styles and templates.
- CSS, e.g. background colour, background images, text formatting, borders, padding, heading styles, element position.
- Embedded multimedia/digital asset content, e.g. digital animation, digital graphics, digital audio, digital video.
- Accessibility features, e.g. alternative tags, zoom features, text-to-speech.
- The World Wide Web Consortium (W3C®) standards for accessibility and HTML compliance.
- Platform compatibility, e.g. browser, operating system, mobile devices.
- Exporting and compressing of digital assets into suitable file types.

Learning aim C: Develop a website to meet client requirements

C1 Client-side scripting languages

The uses and requirements of client-side scripting languages.

- Embedding of original client-side scripts into web pages to provide more interactivity and improve the usability of the website.
- Types of web-scripting languages, e.g. JavaScript, VBScript.
- Uses of scripting languages, e.g. alerts, confirming choices, browser detection, creating rollovers, checking/validating input, handling forms.
- Constructs, e.g. syntax, loops, decision making, functions, parameter passing, handling events, methods.

C2 Website development

Use of tools and techniques for the development of websites.

Creation of interactive websites, including:

- use of CSS, e.g. HTML tags, CSS frameworks, box model, access CSS from HTML, doc types
- use of original client-side scripting
- compatibility with mobile and tablet devices
- effective use of tools and techniques
- the uploading of files to a web server or host computer/device.

C3 Website review

The implications of working with a client to improve the quality, suitability and appropriateness of the interactive websites.

Reviewing interactive websites, including:

- quality in comparison with other similar websites
- suitability for intended purpose and audience
- suitability against the client's requirements, including optimisation
- local legal and ethical constraints
- strengths and improvements.

C4 Website optimisation

Understand the concepts of testing and optimising the website in order to meet client requirements.

Optimising an interactive website, including:

- performance and user testing
- obtaining and evaluating feedback from others
- checking interactivity
- checking compatibility
- refinements and making improvements to meet client needs to optimise the website.

C5 Skills, knowledge and behaviours

The skills, knowledge and behaviours required when implementing websites.

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the website and their suitability against the original requirements.
- Demonstrate own behaviours and their impact on outcomes, to include professionalism, etiquette, supporting others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Understand the principles of website development</td><td rowspan="2">A.D1 Evaluate how the principles of website design are used to produce creative, high-performance websites that meet client requirements</td></tr>
<tr><td>A.P1 Compare the principles of website design used in two websites, including their suitability for the intended audience and intended purpose.</td><td>A.M1 Analyse how the principles of website design are used to produce creative, high-performance websites that meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim B: Design a website to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the design and optimised website against client requirements.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a website.</td></tr>
<tr><td>B.P2 Produce designs for a website that meet client requirements.
B.P3 Review the website design proposals with others to identify and inform improvements.</td><td>B.M2 Justify the design decisions, explaining how they will meet the user's needs and be fit for purpose.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a website to meet client requirements</td></tr>
<tr><td>C.P4 Produce a website for an intended audience and test the website for functionality, compatibility and usability. purpose.
C.P5 Test the website for functionality, compatibility and usability.
C.P6 Review the extent to which the website meets client requirements.</td><td>C.M3 Optimise a website to meet client requirements.</td></tr>
</table>

Essential information for assignments

This unit is assessed using a Pearson Set Assignment Brief. A set assignment must be used to assess learners.

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to software resources that will allow them to use tools and techniques (given in the unit content) to design and develop websites. For example, text editors (such as Notepad®++), rapid authoring software (such as Dreamweaver®, KompoZer), File Transfer Protocol (FTP) service (such as FileZilla®) to upload websites to a web server.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will give a detailed and balanced evaluative report that explains how the two sites meet user requirements. This must be explored further by identifying the requirements of the websites, for example it has a secure login, and why these are important for the user. Learners will discuss what overall impact the site will have on the organisation, including positive and negative outcomes. The report will demonstrate high-quality written/oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will show a clear understanding of how the two sites employ different principles of website design to develop websites that are creative and high performing. Learners will give a detailed analysis of how user needs and principles of website design impact on the design and development of a website. The report must provide a balanced discussion, supported by reasoned examples. It will be technically accurate and demonstrate good-quality written/oral communication.

For Pass standard, learners will give a detailed comparison of two similar commerce sites, with an explanation of who the site is aimed at and its purpose. Learners will explain the use of design principles in each website to compare their application. The evidence may have some inaccuracies and the comparison may be unbalanced.

Learning aims B and C

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the design, development, maintenance, optimisation and testing stages of their website impacted on the overall outcomes. They will consider whether the website meets client requirements, including achieving its stated purpose and appealing to the target audience. Learners will justify their designs and provide a discussion on why alternative designs were not used.

Learners will give a detailed and balanced evaluation of how effectively their completed website meets the client requirements, including appealing to the target audience and meeting its stated purpose, in comparison to alternative solutions. Their evaluation will be supported by evidence from all stages of the project to reach conclusions and

suggest developments. The evaluation must contain a systematic and accurate review of their own skills, performance and behaviours and the impact that this had on the development of the final website. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure, and showing responsible use of quoted materials. Creativity will be shown, for example, by taking innovative approaches to problem solving and through the originality of their solution.

For Merit standard, learners will apply their knowledge through selection and application of appropriate methodologies to design, develop, maintain and test an effective, optimised website to meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their website, learners will produce an optimal solution to meet client requirements as closely as possible. Learners will also gather and analyse feedback on their website in order to make improvements. Learners will record the changes that are made and produce subsequent versions of the website as appropriate.

Learners will give a clear analysis of the success of their solution, giving accurate and reasoned suggestions as to how the solution could be improved; they will discuss alternative solutions that could be implemented if the task were to be repeated. They will consider how decisions they made during the project affected the outcomes and justify why these decisions were made. They will give an evaluation of how their skills and behaviours affected the outcomes of the website.

For Pass standard, learners will apply understanding through the planning and development of the website to meet client requirements. Learners will produce detailed designs for their website, including user requirements, visual designs and technical documentation. Learners will carry out and document a number of tests and reviews of the website (including use of test users and appropriate test plans, schedules and test data) to ensure that the solution works and meets the identified criteria. They will give evidence that different types of testing have been carried out and that important problems and errors identified have been responded to. Learners' websites will be functional and meet the identified requirements but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be.

Learners will review how the decisions they made during planning and development affected the website. Learners will explain the extent to which the website meets the initial project brief. They will consider both positive and negative aspects of the website, although their review may be unbalanced and/or superficial. They will make reference to the possible alternative solutions that could be implemented.

Assessment controls

Time: this assignment has a recommended time period, this is for advice only and can be adjusted depending on the needs of learners.

Supervision: you should be confident of the authenticity of learner's work. This may mean that learners be supervised.

Resources: all learners should have access to the same types of resources to complete the assignment.

Research: learners should be given the opportunity to carry out research outside of the learning context if required for the assignment.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 3: Using Social Media in Business
- Unit 4: Programming
- Unit 7: Mobile Apps Development
- Unit 11: Cyber Security and Incident Management
- Unit 12: IT Technical Support and Management
- Unit 14: Customising and Integrating Applications
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 16: Digital 2D and 3D Graphics
- Unit 17: Digital Animation and Effects.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop website solutions
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 7: Mobile Apps Development

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners investigate mobile apps and design, and develop an application intended for use on mobile devices.

Unit introduction

Millions of people carry a mobile device that rivals the capability of many desktop computers. These devices offer a broad range of functionality by bringing together many different technologies. To develop high-quality mobile apps, you must have an understanding of how they are designed to run specifically on mobile devices and how you can exploit the technologies currently available to ensure an effective final product.

In this unit you will investigate mobile apps, how they are used, why they are created, the differences between devices and the implications of creating and using software on mobile devices. You will study the design considerations inherent in mobile apps and general software design. You will design, develop, test and review a mobile app to fulfil a specific set of client requirements.

With over a million apps on both Apple App Store™ and Google Play Store™, and the growing popularity of Microsoft Windows® mobile devices, the mobile app development industry is highly competitive and continually expanding. Many organisations use mobile apps to support their operations in one way or another. Mobile app development is an important skill for software developers who wish to retain their competitive edge. This unit will help you to progress to an app development role and gives you a basis for further study of the design and development of mobile apps and services.

Learning aims

In this unit you will:

A Investigate mobile apps and mobile devices

B Design a mobile app that utilises device functions

C Develop a mobile app that utilises device functions.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate mobile apps and mobile devices	**A1** Types of mobile apps **A2** Context of mobile apps **A3** Mobile device integration **A4** Mobile app programming	A report evaluating bespoke mobile apps running on different mobile devices. An analysis of mobile device functions and the context in which mobile apps are used.
B Design a mobile app that utilises device functions	**B1** Requirements for an app **B2** Designing a mobile app	Analysis, design and development of a mobile app. An analysis of context. Product design documents. A log of the development process, annotated code, screenshots of running app or demonstration of app running on a mobile device. Testing documentation, including a test log, log of errors and any resolutions made.
C Develop a mobile app that utilises device functions	**C1** Content preparation for mobile apps **C2** Developing a mobile app **C3** Testing a mobile app **C4** Lessons learned from developing a mobile app **C5** Reviewing own skills, knowledge and behaviours	

Content

Learning aim A: Investigate mobile apps and mobile devices

A1 Types of mobile apps

Characteristics and implications of different types of mobile applications.

- Native apps – those that are programmed for, and installed on, a specific mobile platform.
- Web apps – remote apps not required to be installed on the device, e.g. mobile web pages.
- Hybrid apps – cross-platform-compatible scripting that can be installed on a device.

A2 Context of mobile apps

The features, purpose and context of mobile apps impact on their design, development and use, including:

- locale, e.g. maps
- utility, e.g. file manager
- productivity, e.g. office
- immersive full screen, e.g. games
- entertainment, e.g. music players
- widgets, e.g. news ticker, quick device settings.

A3 Mobile device integration

Characteristics and implications of integrating mobile app services on different mobile devices.

- Using device functions, e.g. accelerometer, global positioning system (GPS).
- User interface, e.g. small screen, touch screen.
- Operating system, e.g. Android, iOS®.
- Device permissions, e.g. read phone status, network access, read contacts.

A4 Mobile app programming

The development options and environments for developing apps.

- Programming languages, e.g. Java™, Objective-C®.
- Programming environments, e.g. Android Studio, Xcode®.

Learning aim B: Design a mobile app that utilises device functions

B1 Analyse requirements for an app

The concepts of mobile computing requirements of an identified situation.

- Device capabilities required, e.g. accelerometer, GPS.
- Input required, e.g. touch screen, voice, timed event.
- Output required, e.g. video, audio, vibration.
- The user's needs, e.g. location-based services, accessibility considerations.

B2 Designing a mobile app

Appropriate design documentation for a mobile app to meet identified requirements.

- User requirements.
- A proposed solution:
  - description of program tasks
  - target platform(s)
  - screen layouts and navigation
  - algorithms, e.g. pseudo code, activity diagrams
  - control structures
  - data validation
  - integration of device capabilities, i.e. how, when and where device capabilities will be utilised.
- Alternative solutions.
- Details of resources and assets to be used:
  - predefined code
  - video, graphical, audio.
- Test and review schedule.
- Constraints, e.g. time, phone permissions, phone capabilities, limitation of platform.
- Local legal and ethical considerations.

Learning aim C: Develop a mobile app that utilises device functions

C1 Content preparation for mobile apps

The application of appropriate processing and editing techniques to prepare resources for each specific device and purpose.

- Optimisation, e.g. file size, image size, selecting/removing sections of prewritten code.
- Alternative formats for screen orientation, e.g. landscape, portrait.
- File formats, i.e. compatibility.
- Compression.
- Encryption.

C2 Developing a mobile app

Producing a mobile app to meet identified requirements through the use of appropriate programming language(s), tools and/or development environments, e.g. Android Studio, Xcode.

- Programming constructs:
  - constants
  - operators; arithmetic, logical
  - reserved words, e.g. public, final
  - input and output commands
  - local variables
  - global variables
  - assignment
  - sequence
  - selection
  - iteration.

- Functions and procedures.
- Data types, e.g. char, integer, real, Boolean.
- Objects and classes.
- Event handling, e.g. forms, screen components, actions.
- Utilise device capabilities, e.g. language APIs, Android Sensor, iOS Core Motion Framework.
- Interrogate device status, e.g. location, battery life.
- Orientation of device, e.g. autodetection, force orientation mode.
- Code annotation.
- Create executable for target device.
- Quality control:
  - efficiency and performance, e.g. system resources used, accessing storage media
  - maintainability, i.e. the ease of modification and improving the app
  - portability, i.e. range of device compatibility
  - usability, i.e. ease of use, how easily the user can interact with the app.

C3 Testing a mobile app

The appropriate testing methodologies to ensure the mobile app meets the identified requirements.

- Test plans and test data.
- How and what to test:
  - functionality, e.g. all utilities work as intended
  - acceptance, e.g. fitness for purpose
  - performance, e.g. stress loading
  - usability, e.g. users can complete tasks easily
  - compatibility, e.g. different model/brand of phone.
- Selecting appropriate test users.
- User feedback, i.e. response from end users regarding the app.
- Analysis of user feedback:
  - collation of results
  - identification of trends, e.g. '60% of users suggested… '.
- Improving and refining the app:
  - making use of the outcomes of testing and review
  - change logs
  - versioning
  - optimising the app, e.g. exporting assets to different file formats, improving the efficiency of code, developing the user interface based on review and feedback.

C4 Lessons learned from developing a mobile app

Evaluate the effectiveness of the app that has been developed.

- The extent to which the solution met the identified requirements.
- Issues arising during testing and refinement.
- How the final app could be improved to better meet the needs of the user and fulfil the identified client requirements.
- Alternative solutions that could be implemented if the task were to be repeated.

C5 Reviewing own skills, knowledge and behaviours

The skills, knowledge and behaviours required when implementing mobile apps.

- Planning and recording opportunities for skills, knowledge and behaviours development, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills knowledge and behaviours development, including the use of feedback from others.
- Own behaviours and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability.
- Evaluating targets set for skills, knowledge and behaviour development to obtain insights into own performance.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate mobile apps and mobile devices</td><td rowspan="2">A.D1 Evaluate how the effectiveness of mobile app implementation and design are affected by the intended user, current technologies and the purpose of the app.</td></tr>
<tr><td>A.P1 Explain how the purpose of a mobile app and the needs, preferences and characteristics of the user affect its design and the provided features.
A.P2 Explain the impact of current technologies on the design and implementation of mobile apps.</td><td>A.M1 Analyse how the implementation and design of mobile apps is affected by the intended user, current technologies and the purpose of the app.</td></tr>
<tr><td colspan="2">Learning aim B: Design a mobile app that utilises device functions</td><td rowspan="3">BC.D2 Evaluate the design and optimised mobile app against client requirements.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a mobile app.</td></tr>
<tr><td>B.P3 Produce designs for a mobile app to meet identified requirements.
B.P4 Review the mobile app designs with others to identify and inform refinements.</td><td>B.M2 Justify how decisions made during the design process ensure the design for the app will meet identified requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a mobile app that utilises device functions</td></tr>
<tr><td>C.P5 Produce a mobile app that meets the design criteria.
C.P6 Test a mobile app for functionality, usability, stability and performance.
C.P7 Review the extent to which the mobile app meets the identified requirements</td><td>C.M3 Optimise a mobile app that meets the design criteria.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim A: (A.P1, A.P2, A.M1, A.D1)

Learning aims B and C: (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- an integrated development environment with support for mobile development such as Android Studio, Eclipse®, Xcode® or similar
- mobile devices, such as Android phones or tablets, Apple® phones or tablets, or similar are also required in order to enable learners to meet assessment criteria.

Essential information for assessment decisions

Learning aim A

Learners must have access to more than one mobile device configuration to allow for a full investigation and evaluation of the chosen apps, for example different versions of mobile device operating system, mobile phones or tablets.

Learners will investigate at least two different apps that have implementations on at least two different mobile platforms, for example, iOS and Android. The chosen examples must provide learners with enough scope to examine a range of current technologies and design features, and the ways in which they are implemented on different systems.

For Distinction standard, learners will provide a clear and balanced evaluation of how the capabilities and constraints of different devices and platforms impact on the success of mobile phone apps implementation. Learners will provide clear examples of how they used the principles of mobile design, the requirements of the user and current technology, and how successful and/or appropriate these were to the identified situation. Learners must make comparisons between different apps and different implementations of the same app, making justified suggestions for improvements. The evidence will demonstrate high-quality written/oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will show a clear understanding of how the context in which the app is designed to operate impacts on its design, development and use. The analysis must provide a balanced discussion as to how user needs, the tasks that are to be performed and the current technologies (including target platform and device capabilities) impact on features available in the apps and the way in which features are implemented. The report will be technically accurate and demonstrate good-quality written/oral communication.

For Pass standard, learners will explain how a mobile app's design and features are affected by the task(s) that it must perform and the needs and preferences of the user. The descriptions will be supported by relevant examples of how these needs and preferences are met in at least two different mobile phone apps. Learners will explain how the technologies currently available on mobile platforms affect the ways in which an app is designed and implemented. Learners will support their explanations with examples from the identified apps. Learners will explain how apps that have implementations on two or more devices make use of technologies currently available on the target platform and how the implementations differ from each other in terms of design, use and application. The evidence may have some inaccuracies and the explanations may be unbalanced.

Learning aims B and C

Learners must have access to more than one mobile device configuration to allow for design for multiple devices and implementation of a developed app onto a mobile device. For example, different versions of mobile device operating systems, mobile phones or tablets.

Learners must develop a mobile app that is of sufficient complexity to demonstrate appropriate use of a range of technologies/functions offered by modern mobile devices.

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the design, development, maintenance, optimisation and testing of the mobile app impacted on its effectiveness. Learners will justify their designs and provide a discussion on why alternative designs were not used.

Learners will provide a detailed evaluation of their completed app's effectiveness in comparison to alternative solutions. Their evaluation must be supported by evidence from all stages of the project to reach conclusions and suggest future developments. It will contain a systematic and accurate review of their own skills, performance and behaviours, and the impact that this had on the effectiveness of the final app.

Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. They will show creativity, for example by taking innovative approaches to problem solving and through the originality of their solution.

For Merit standard, learners will apply their knowledge through the selection and application of appropriate methodologies to design, develop, maintain and test an effective, optimised mobile app to meet identified requirements. Learners will produce comprehensive designs to cover multiple devices, alternative solutions and use of device functions. Learners must make use of feedback from others to help improve and refine the designs to create a solution. They will justify decisions made when developing the design. When developing their app, learners will produce optimal code in order to implement the required device functions in the most efficient way.

Learners will gather and analyse feedback on their app in order to make improvements. They will record the changes that are made and produce subsequent versions of the app as appropriate.

Learners must optimise their apps by making use of testing and feedback throughout development to improve and refine the final solution, for example resampling and exporting assets to different file types to reduce demands on system resources, making use of additional phone features, enhancing the user interface.

Learners must provide a clear and balanced analysis of the success of their solution, giving accurate and reasoned suggestions as to how it could be improved. They will discuss alternative solutions that may be implemented if the task were to be repeated. They must consider how decisions they made during the project affected the outcomes and justify why they made these decisions.

For Pass standard, learners will apply understanding through the planning and development of a mobile app to meet identified requirements. Learners will produce detailed designs for their mobile app, including user requirements, visual designs and technical documentation. Learners must show evidence that they have sought feedback on their suggested solutions and made use of this feedback to create a final design.

Learners must carry out and document a number of tests and reviews of the mobile app, including use of test users and appropriate test plans, schedules and test data, to ensure that the solution works and meets the identified criteria. They will provide evidence that different types of testing have been carried out and that important problems and errors identified have been addressed.

Learners must install the app on a target device and it must work, but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be.

Learners will review how the decisions they made during planning and development affected the final app, explaining to what extent it meets the initial project brief. They must consider both positive and negative aspects of the app, although their review may be unbalanced and/or superficial. Learners will make reference to the possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 3: Using Social Media in Business
- Unit 4: Programming
- Unit 6: Website Development
- Unit 8: Computer Games Development
- Unit 9: IT Project Management
- Unit 11: Cyber Security and Incident Management
- Unit 12: IT Technical Support and Management
- Unit 14: Customising and Integrating Applications
- Unit 16: Digital 2D and 3D Graphics
- Unit 17: Digital Animation and Effects.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop mobile app solutions
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 8: Computer Games Development

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners investigate the computer games industry and its impact on technological and social trends. They will design and develop a computer game to meet requirements.

Unit introduction

The computer games industry has been growing year on year and has become a multi-billion industry. With the prevalence of computing devices, games consoles and mobile devices, this growth shows no sign of slowing. Many computer games are vast productions involving a range of people such as programmers, graphical artists, animators, level designers, actors and directors. As a games developer, you will analyse the needs of a client and understand the potential and limitations of different gaming solutions.

In this unit, you will investigate the technologies used in the computer gaming industry and the implications they have for users, developers and organisations. You will analyse how user needs and preferences impact on game design and how target technologies affect the design and development of a computer game. Finally, you will design, create and review a computer game to meet requirements and reflect on the skills and understanding applied during the design and development process.

You will apply analytical skills that would be used by any software developer to investigate the available technologies and current trends in order to design and develop appropriate software solutions. The skills you gain through this unit will benefit you as you progress to employment in the computer gaming industry, for example in computer games developer and software developer roles.

Learning aims

In this unit you will:

A Investigate technologies used in computer gaming

B Design a computer game to meet client requirements

C Develop a computer game to meet client requirements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate technologies used in computer gaming	**A1** Social trends in computer gaming **A2** Technologies used in computer gaming	A report investigating and evaluating social and technological trends in gaming and how they would influence the development of new computer games.
B Design a computer game to meet client requirements	**B1** Computer games design processes and techniques **B2** Design documentation **B3** Reviewing and refining designs	A design specification showing the design and development of a computer game to meet identified client requirements. Project brief, design documentation, development and testing logs, meeting notes and a report that evaluates the effectiveness and appropriateness of the computer game. The evidence should also suggest ways in which solutions could be improved and/or alternative solutions that could be used if the task were to be repeated.
C Develop a computer game to meet client requirements	**C1** Principles of computer games development **C2** Developing computer games **C3** Testing computer games **C4** Reviewing computer games **C5** Quality characteristics **C6** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate technologies used in computer gaming

A1 Social trends in computer gaming

The concepts and challenges of social trends relevant to computer games.

- Popular genres.
- Players, e.g. age range, gender, casual gamers, immersive gamers, themes.
- Game production, e.g. mainstream publisher, indie, free to play
- Multiplayer.
- Artificial intelligence, e.g. search algorithms, mathematical optimisation, logic.
- Emerging technologies.
- Security of integrated services and multiplayer environments.

A2 Technologies used in computer gaming

The technological options and limitations of different platform options for the development of computer games.

- Benefits and limitations of different platform options for the development of computer games:
  - personal computers, e.g. Windows®, Mac®
  - consoles, e.g. PlayStation®, Xbox®, Nintendo®
  - mobile devices, e.g. smartphones, tablets, notebooks
  - web based, e.g. Adobe Flash®, HTML5.
- Hardware options and their effect on the development of computer games, including:
  - central processing unit (CPU)
  - graphics processing unit (GPU)
  - memory, e.g. random-access memory (RAM), read-only memory (ROM)
  - output, e.g. display, sound
  - input, e.g. keyboard/mouse, touch, gamepad, joystick, kinetic, voice
  - storage, e.g. hard disk drive, cloud
  - connections, e.g. internet, local area network, mobile network
  - new technologies.
- Software options and their effect on the development of computer games, including:
  - operating systems
  - programming languages
  - device drivers
  - graphic options
  - audio options, e.g. music, ambiance, file format.
- Uses of game engines, their capabilities and how they aid computer game developers, including:
  - rendering engines
  - physics engines
  - collision detection
  - scripting
  - animation.

Learning aim B: Design a computer game to meet client requirements

B1 Computer games design processes and techniques

The processes and techniques of computer games design.

- Mathematical techniques and processes.
- Graphic processing and editing techniques.
- Platform and delivery.
- Visual styles.
- Assets.
- Game play features, to include:
  - interaction model, e.g. avatar, omnipresence
  - participation, e.g. single player, multiplayer
  - narrative, e.g. story, dialogue
  - game setting, e.g. physical, temporal, environmental, emotional, ethical
  - goals, e.g. what the player needs to achieve in the game
  - challenges, e.g. what the player must overcome
  - rewards, e.g. what the player will receive for completing goals or challenges
  - player actions, e.g. run, jump
  - rules, e.g. valid moves, how high the player can jump
  - feedback, e.g. how the player knows their progress
  - difficulty, e.g. degree of challenge
  - game mechanics, e.g. inventory, scoring, win condition
  - game structure, e.g. storyboard, flow chart, activity diagram
  - quality, e.g. compatibility, performance, gaming experience.

B2 Design documentation

Game design and documentation requirements driven by the priorities of an organisation.

- Requirements of the brief, including audience, purpose and client requirements.
- Local legal and ethical considerations applicable.
- Game design, to include:
  - type of gameplay
  - data dictionary
  - algorithm design, e.g. pseudo code
  - storyboards, flow charts, activity diagrams
  - visual styles, e.g. world (terrain, architecture, objects), characters, non-playing characters, feedback interface, perspectives (2D, 3D, first person, third person, scrolling, aerial and context sensitive)
  - full-motion video
  - assets, e.g. graphical, audio and video
  - gameplay features.
- Choice of programming languages, application program interface (API) and computer game development kits.
- Intended platform/media for delivery.

- Timeline, e.g. outlining which different assets are included and when different assets will be combined.
- Production schedule, e.g. timeline of development.
- Hardware, software and other resources required.
- Test plans to check playability, performance and other quality characteristics.
- Constraints, e.g. platform limitations.

B3 Reviewing and refining designs

The implications of working with clients and others to improve the quality, effectiveness and appropriateness of designs.

- Gathering feedback from client(s) and potential users.
- Communicating with clients, e.g. email, verbal communication.
- Scheduling and documenting meetings.
- Agreeing and adjusting timescales.
- Refining ideas and solutions.
- Updating design schematic documentation based on review and feedback.

Learning aim C: Develop a computer game to meet client requirements

C1 Principles of computer games development

The concepts and principles of computer game development.

- Design schematics.
- Computational processes applied to computer games development, e.g. use of rendering engines.
- Principles of mathematics applied to computer games development, e.g. vector, physics.
- Prototyping and game engine selection.
- Tools and techniques used to develop computer games.
- Quality characteristics used to test and assess suitability of computer games.
- Technical constraints.

C2 Developing computer games

The use of features and functions to support computer game development.

- Visual style:
  - omnipresent, e.g. area of vision
  - avatar, e.g. line of sight.
- Input methods:
  - keyboard and mouse
  - gamepad
  - customisation of control, e.g. user configuration.
- Asset integration, to include:
  - graphical, e.g. raster, vector
  - animation and video, e.g. cut scene, story, arc
  - audio, e.g. syncing sound clips with visual displays
  - texture mapping, e.g. applying texture to a mesh.

- Advanced features, to include:
  - artificial intelligence, e.g. search algorithms, learning algorithms
  - 3D rendering, e.g. 3D environment, first-person view
  - save game state, e.g. options to save, auto-save points
  - multiple players, e.g. multiple player controls, via network
  - player progression, e.g. achievements, leader boards.

C3 Testing computer games

The application of formative and summative testing, including feedback from others.

- Test computer games, including playability, compatibility, stability and acceptance.
- Obtain feedback from others, e.g. effectiveness, presentation, performance, accessibility, portability, robustness, purpose.
- Make improvements and/or refinements to computer games in response to testing and feedback from others.

C4 Reviewing computer games

The concepts of making improvements and/or refinements to the computer game in order to meet client requirements.

- Quality of the computer game.
- Suitability for audience and purpose.
- Suitability against the original requirements.
- Local legal and ethical constraints.
- Technology constraints.
- Strengths and improvements.
- Platforms and compatibility.

C5 Quality characteristics

The principles of quality characteristics.

- Sources of quality characteristics which can be measured suitably against computer games, including playability, performance and presentation.

C6 Skills, knowledge and behaviours

The skills, knowledge and behaviours required when implementing computer games.

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the computer games and their suitability against the original requirements.
- Demonstrate behaviour and its impact on outcomes, to include professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.

- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use), verbal communication requirements (one-to-one and group informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate technologies used in computer gaming</td><td rowspan="2">A.D1 Evaluate the impact of current and emerging technologies on the design and development of computer games to meet the requirements of the users and the computer games industry.</td></tr>
<tr><td>A.P1 Explain social and technological trends of computer games.
A.P2 Explain how current and emerging technologies impact computer games' design and development.</td><td>A.M1 Discuss how current and emerging technologies impact on how games are designed and developed to meet the requirements of the users and the larger computer games industry.</td></tr>
<tr><td colspan="2">Learning aim B: Design a computer game to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the design and optimised computer game against client requirements.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a computer game.</td></tr>
<tr><td>B.P3 Produce designs for a computer game that meet client requirements.
B.P4 Review the designs with others to identify and inform refinements.</td><td>B.M2 Justify decisions made, showing how the design will fulfil its purpose and client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a computer game to meet client requirements</td></tr>
<tr><td>C.P5 Produce a computer game to meet client requirements.
C.P6 Test a computer game for functionality, usability, stability and performance.
C.P7 Review the extent to which the computer game meets client requirements.</td><td>C.M3 Optimise a computer game to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to computer software resources that will allow them to use the tools and techniques (given in the unit content) to design and develop computer games, for example game engines such as Unity®, Unreal Development Kit™, or similar.

Essential information for assessment decisions

Learning aim A

Centres may wish to focus on particular areas such as specific consoles, devices, or genres of computer games. Learners must however be given the opportunity to explore alternative areas during their investigation and design.

The evidence must include discussion of social and technological trends in computer gaming and how these trends influence the design and development of computer games.

For Distinction standard, learners will provide a clear and balanced evaluation of current and emerging technologies, and a comparison of how they impact on the development of a computer game to meet the requirements of the users and the game industry. Learners will provide clear examples of current and emerging technologies and the requirements of the users and the games industry. Learners must make comparisons between different technologies and how they impact on the games industry and the requirements and expectations of users. The report will demonstrate high-quality written/oral communication through the use of accurate and fluent, technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will show a clear understanding of how available and emerging technologies affect the development of a computer game. The report must provide a balanced discussion as to how user needs and current and emerging technologies impact on the design and development of a computer game. The report will be technically accurate and demonstrate good quality written/oral communication.

For Pass standard, learners will provide descriptions of how current and emerging technologies in gaming impact on the users and the games industry. The descriptions must be supported by examples of current and emerging technologies. Learners will explain the technologies available in gaming and how they affect the design and implementation of a game. Learners must support their explanations with examples from existing computer games and how they make use of the technologies available during development. The evidence may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners must provide evidence of planning and developing a computer game. The computer game must be of sufficient complexity to show use of a range of appropriate software development tools and techniques.

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims in evaluating how the decisions and processes applied throughout the planning, development and testing stages impacted on the effectiveness of the computer game. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners must provide a thorough evaluation of the effectiveness of the content produced against the design and client requirements. In order to reach valid conclusions as to how the chosen processes and techniques provided more appropriate content in comparison to alternatives, the evaluation will be supported by evidence from all stages of the planning, development and review processes. Learners will provide well-considered, justifiable suggestions for improvements to the computer game.

The evaluation must contain a systematic and accurate review of their own skills and performance and the impact that this had on the effectiveness of the solutions. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of a project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For Merit standard, learners will apply their knowledge through selection and application of appropriate methodologies to plan, design, develop, test and optimise a computer game that effectively meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their game, learners must produce an optimal solution in order to meet client requirements as closely as possible. Learners will also gather and analyse feedback on their game in order to make improvements.

The sourcing, development and testing stages must be well documented, with clear justification of decisions and selections made throughout. Learners will record the changes that are made and produce subsequent versions of the game as appropriate. Learners will make clear reference to the client requirements and target platform. They will consider local legal and ethical issues as appropriate.

Learners must provide a clear, accurate and robust justification of how the design decisions will ensure the product is appropriate for the use for which it was intended and fully meets client requirements.

Learners will source a wide range of digital content in preparation for processing and editing with appropriate, dedicated editing software. The evidence will demonstrate accurate and appropriate use of visual and audio effects to fully meet the client requirements.

Learners must optimise their computer game by making use of testing and feedback throughout development to improve and refine the game to fully meet client requirements.

Learners will provide a clear and balanced analysis of the success of their outcomes against the design and client requirements, and the quality of the computer game. Learners will refer to how the computer game suits the intended audience, purpose and platform of delivery. Learners must also provide an analysis of how any associated local legal and ethical issues were considered and met. They will make accurate and reasoned suggestions as to how the computer game could be improved and will discuss alternative planning, sourcing and processing methods that could be used if the task were to be repeated.

For Pass standard, learners will apply understanding through the planning and development of virtualised solutions to meet client requirements. Learners will provide an explanation of the computer game requirements, and related computing requirements, of an identified client and identify the success/acceptance criteria that will ensure the client's requirements are met.

Learners will produce detailed designs for their computer game, including user requirements, visual designs and technical documentation. Learners must consider the appropriateness of different possible techniques and formats and the impact these would have on user experience. Learners must carry out and document a number of tests and reviews of the computer game, including use of test users and appropriate test plans, schedules and test data, to ensure that the solution works and meets the identified criteria. Learners must review their designs with others to identify improvements and refinements. They will provide evidence that different types of testing have been carried out. Learners' games will be functional but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be. Learners must show some awareness of the local legal and ethical considerations related to producing computer games.

Learners must provide appropriate documentation for the planning, design, development, production and quality assurance of their computer game, explaining the decisions they made during the project to ensure they met the project brief. Learners will produce a solution that meets the requirements of the client, however, some small issues of optimisation may persist.

Learners must provide a review of whether their work meets the client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions for the possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 4: Programming
- Unit 9: IT Project Management
- Unit 11: Cyber Security and Incident Management
- Unit 12: IT Technical Support and Management
- Unit 16: Digital 2D and 3D Graphics
- Unit 17: Digital Animation and Effects.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop computer games
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 9: IT Project Management

Level: 3
Unit type: Internal
Guided learning hours: 90

Unit in brief

Learners investigate a range of project management principles and methodologies and undertake the management of a 'live' or 'simulated' IT project from start to finish.

Unit introduction

Project management is the art of coordinating resources, both human and machine, and solving problems to complete an agreed set of objectives and/or to deliver benefits in a fixed time period, budget and to a specified quality. Ensuring the quality of IT projects in any sector is an essential requirement.

In this unit, you will investigate the principles of project management and different project management methodologies, as used in the IT industry. You will deliver an IT project using at least one project management methodology and complete the five main stages of a project. You will initiate the project by researching a problem and using your creative skills to generate a range of solutions, undertaking a feasibility study to select an appropriate solution and outline the requirements of the project. You will undertake the planning, execution, and monitoring and control stages of the project, either through simulation or by undertaking a major project as part of your BTEC course, which could involve the integration of several units. You will close the project by reflecting on the success of the project outcome and your personal performance.

The analytical and problem-solving skills and knowledge you gain in this unit will prepare you for entry to higher education to study a range of degrees. The unit will help you when entering an IT apprenticeship or the workplace, for example working alongside a project manager.

Learning aims

In this unit you will:

A Investigate the principles and methodologies of IT project management as used in industry

B Carry out a project initiation for an IT project

C Carry out the planning, execution, monitoring and controlling of an IT project, using an appropriate methodology

D Undertake the closure of a project by reflecting on the success of personal performance and the project outcome.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the principles and methodologies of IT project management as used in industry	**A1** Project definitions **A2** Characteristics of project management methodologies **A3** Project management structures	A written report on the investigation of principles and methodologies of IT project management as used in the industry, using at least three different IT projects as case studies.
B Carry out a project initiation for an IT project	**B1** Project idea generation and solution creation **B2** Feasibility study **B3** Project requirements	A project document portfolio created from implementing either a 'live' or 'simulated' project using an appropriate methodology. Evidence will include planning, preparation, feasibility studies, requirements and records of processes carried out during the planning and execution of a project. Written or verbal reports should accompany the evidence where clarifications and justifications are required, and versioned document control should be applied.
C Carry out the planning, execution, monitoring and controlling of an IT project, using an appropriate methodology	**C1** Project phasing **C2** Typical project management processes	
D Undertake the closure of a project by reflecting on the success of personal performance and the project outcome	**D1** Lessons learned from implementing an IT project	A written report or presentation evaluating the outcome of the 'live' or 'simulated' project and reflecting on personal performance.

Content

Learning aim A: Investigate the principles and methodologies of IT project management as used in industry

A1 Project definitions

The concepts, principles and methodologies of IT projects that include software application development, installing IT systems and networks, and information collection and analysis.

- A project has a defined beginning and end point in time, and a defined scope of work to be completed for a given objective and/or benefit.
- Project management is the art of planning, organising and controlling project activities so that the project is completed successfully within the budget, time and quality constraints, and that problems are resolved to an appropriate standard and appropriate risks are mitigated.
- A project life cycle has the following five main stages and the structure in which these are implemented will vary depending on which project management methodology is being applied.
  1. Initiating: the first stage of a project that outlines the justification and requirements.
  2. Planning: provides details about how the project work will be carried out, and how it will be monitored and controlled.
  3. Executing: the human and machine resource required to undertake tasks within the constraints of time, cost and quality.
  4. Monitoring and controlling: to monitor and control the project in accordance with the initiation and planning documents.
  5. Closing: once the project is complete, it can be formally closed down and a review held to learn from both the successes and the mistakes made during the project.

A2 Characteristics of project management methodologies

The characteristics of different project management methodologies make them suitable for delivering certain types of project.

PRojects IN Controlled Environments (PRINCE2®)

- This methodology is suitable for the vast majority of projects, regardless of industry or market, size or complexity.
- Understand what is involved at each stage of the PRINCE2 methodology, including:
  - starting up a project (SU), e.g. forming the project board, appointing the project manager and team, preparing the project brief, defining the approach, outlining the business case, learning from previous experience and preparing the next stage
  - initiating a project (IP), e.g. planning, refining the business case, risk planning, project controls, project files, project initiation documentation
  - directing a project (DP), e.g. authorisation of initiation, authorisation of project, authorisation of a stage, ad hoc direction, closing project
  - controlling a stage (CS), e.g. work packages, assessing progress, capturing and examining issues, managing and controlling risk, reviewing stages, escalating issues, reporting, delivering packages
  - managing product delivery (MP), e.g. accept, execute and deliver work packages

  - managing a stage boundary (SB), e.g. planning and updating a stage and the project board, updating the business case, updating registers, exception plans
  - closing a project (CP), e.g. decommissioning a project, benefits and project end reviews.
- Benefits, including scalability, project size, training requirements, qualified personnel.
- Limitations, including cost of training and qualification, absence of people or contact management.

Rapid application development (RAD)

- This methodology is ideally suited for short-term, large-scale enterprise applications that require high-budget resources.
- Understand what is involved in each phase of the methodology, including:
  - requirements planning, e.g. discussing and agreeing business needs, defining the project's scope, identifying constraints, identifying requirements, agreement between users, managers and IT staff on key issues and obtaining management authorisation
  - user design, e.g. user analysis, systems analysis, developing models and prototypes, showing all processes, inputs and outputs, computer-aided software engineering (CASE) tools:
    - business and analysis modelling, e.g. entity relationships modelling
    - development, design and construction, e.g. GNU Debugger
    - verification and validation, e.g. code analysis
    - configuration management, e.g. content management system (CMS)
    - metrics and measurement, e.g. complexity analysis, Big O
    - project management, e.g. Gantt, schedules
  - construction phase, e.g. programming and application development, unit integration, system testing and cutover, e.g. data conversion, testing, migration from old system, user training.
- Benefits, to include quality, risk control, time and budget.
- Limitations, to include scarce resources, less control, new approach, poor design, lack of scalability for large systems.

Waterfall

- This methodology is ideally suited for websites, database software or network software.
- Understand what is involved in each phase of the methodology, including:
  - requirements, e.g. capturing product requirements and documenting them
  - analysis, e.g. generation of models, schema and business rules
  - design, e.g. user interface (UI) designs, mock-ups, planning of the architecture
  - implementation, e.g. the development, unit testing and integration of the software
  - testing, e.g. discovery of issues and defects, fixes of uncovered issues
  - operation, e.g. installation, migration and delivery of software.
- Benefits, to include suitability for short-term static projects, simple to understand and outputs being visible at each stage.
- Limitations, to include difficulty to explicitly define user requirements at the start of a project and small changes that can cause major delays and/or costs to the project.

Agile

- This methodology is ideally suited for medium- and long-term projects where user requirements can change and outputs are required at timed intervals.
- Understand what is involved in each phase of the methodology, including:
  - iteration 1 phase – where potential projects are analysed before being selected for development, funding provided, and roadmaps produced for technology and the business
  - iteration 0 phase – where the initial modelling, planning and organisation takes place, e.g. prototypes of the products are created and initial requirements and a release plan are defined
  - construction iterations phase – a series of time-constrained iterations consisting of prioritised work items in a 'sprint' where a product is produced, daily meetings to discuss team progress and end of iteration reviews to demo to stakeholders
  - transition and release phase – where the product is released into production as a working system
  - production phase – where the product is delivered to the customer, including the phases of support and maintenance
  - retirement phase – where the product is removed from development.
- Benefits, to include flexibility in constantly changing applications, clear visible outputs during each iteration of development and appropriate planning of resources ensures first to the market and continual releases.
- Limitations, to include teamwork from all stakeholders required to ensure the process is successful, full commitment and effort is required in projects and the need for experienced development teams to make decisions during the project.

A3 Project management structures

The concepts and principles of project management structures.

- User requirements, including:
  - a 'functional requirement' of the system, including the definition of inputs, the process and the outputs, e.g. a calculation, data manipulation process, what it is required to accomplish
  - a 'non-functional requirement' to satisfy in the system, including quality attributes of the system, e.g. performance or maintainability of a system.
- Project job roles and responsibilities:
  - project manager, including developing project plans; managing the stakeholders; managing communication across the team; managing individuals, risks, schedules, budgets, conflicts and delivery
  - systems architect, including design and implementation of hardware and infrastructure, providing definitions of hardware and how it meets the requirements of the system
  - electronics engineer, including designing electronic components, circuits and systems, providing interfaces for software implementation and development of firmware
  - product owner, including role as key stakeholder; identifying priority requirements, work items, release dates; has a vision for the product to be built
  - lead developer, including responsibility for underlying architecture, serving as mediatory between management and the development team body, acting as a mentor to more junior developers
  - developer, including writing software code, applying developer written unit tests

  - quality assurance (QA) test lead, including responsibility for test plans and test suites, delegating work to testers and acting as a mentor to more junior testers
  - QA tester, including functional and non-functional requirement testing against the product, carrying out more general testing
  - IT support technician, including logging and resolving user issues/faults and the operation of the IT services to meet the user's and organisation's needs, e.g. the operation of hardware and software and security systems
  - user, including using the product during deployment, producing requirements based on usability and testing, feeding back to stakeholders such as project managers and product owners.
- QA, including key and continuous process during the development life cycle, ensuring product meets quality standards defined by the product owner and customer.
- Operational test environment – a pre-release environment close in performance and architecture to live or a deployment environment.
- Live deployment – the operational deployment environment for the final product to be released to.

Learning aim B: Carry out a project initiation for an IT project

B1 Project idea generation and solution creation

Identification of a suitable problem, perhaps based on a given theme, and creation of alternative solutions, including:

- researching a given project theme or initial idea and identifying problems to be solved, using tools, e.g. the internet, journals, databases, libraries, publicly available company information
- creativity tools to solve problems, e.g. rewording problems, challenging assumptions, thinking in reverse, mind mapping, drawing a diagram, group discussion, brainstorming and Edward De Bono's Six Thinking Hats®
- a specification that scopes out the alternative technical solutions, including:
  - graphic solutions, e.g. sketches, diagrams, photographs and storyboards
  - an outline of the required processes, e.g. information, systems, assemblies, high-level flow chart
  - an outline of costings, e.g. spreadsheet, material cost, budgets
  - initial technical information, e.g. outline performance parameters.

B2 Feasibility study

A study into the feasibility of the project, identifying the resources and skills required to produce the IT product, service or system, and ensure it is economically viable.

- Technical assessment, including assessing and evaluating the technical resources available.
- Economic assessment, including assessing the cost, benefits and viability of the project.
- Legal assessment, including assessing the current and relevant local legal requirements.
- Operational assessment, including the assessment of how well the proposed solution meets the requirements and solves the problems of the project.

- Scheduling assessment, including the assessment of the likelihood of the project being a success, estimating the time required to complete the project.
- Sustainability assessment depending on the product or service proposed, e.g. environmental impact, waste material, power usage, choice of material, recycling and reuse.
- Security assessment, e.g. analysis of secure servers, software source control, 'penetration' testing.
- Usability assessment, e.g. the appropriate design of user interfaces ensuring smooth and consistent integration with any required systems.

B3 Project requirements

The requirements for documenting to outline the project requirements, including:

- introduction to the project, e.g. purpose of the document, definitions, project overview and references
- overall description, e.g. project perspective, functions and characteristics of the software
- requirements specification, e.g. designs, interfaces, functionality, design constraints, time, budget and scope constraints
- success criteria of the project, how the project could be tested and what the overall goals of the project are.

Learning aim C: Carry out the planning, execution, monitoring and controlling of an IT project, using an appropriate methodology

C1 Project phasing

The concepts and requirements at each stage of the project life cycle.

- The division of larger user requirements into more specific functional and non-functional requirements, generation of requirements specification documentation and acceptance of the documentation by the key stakeholders and the client.
- Understand that implementation covers the planning, execution, monitoring and controlling stages of the project life cycle.

C2 Typical project management processes

The requirements of project management processes, including:

- the development of risks and issues and tasks for development
- prioritising work according to an ongoing plan and project charts
- analysis and management of barriers or constraints that arise during the development of the project
- regular meetings during implementation and with the customer to monitor progress
- ensuring the project is within budget and has appropriate resources.

Planning and monitoring project-management processes

The use of project management tools to plan and monitor a project:

- resource plan, e.g. the internet, humans, peers, books and equipment
- time plan, to include a Gantt chart and critical path analysis to set priorities for different activities

- project contingency, e.g. an amount of time or additional budget that is included in the plan to manage unforeseen events
- project constraints, including time, budget, scope, sustainability, ethical and legal
- monitoring and control of the project at appropriate intervals, including logbook of problems and solutions, support, activities and communications, and progress against the plan and milestones.

Risk and issue processes

The concepts and processes of the risk management process.

- The purpose of risk and issue management:
  - avoiding 'crisis management'
  - improving the probability of success and increasing competitive advantage.
- A risk is a future event that could adversely impact on the project processes or outcome, and an issue is a current event that is adversely or positively impacting on the project process(es) or outcome.
- The risk or issue severity = probability of occurrence × expected impact on the project, e.g. on the customer's requirements, delivery to time and to budget.
- Risks and issues should be assessed throughout the delivery of the project and medium, high and extreme severity risks and issues should be managed.
- Management (monitoring and control) of risks and issues (mitigation), including:
  - identification and severity of risks and issues during the project
  - prevention to eliminate the threat of a risk occurring
  - reduction to reduce the likelihood of a risk occurring or to reduce the impact of a risk or issue
  - acceptance to do nothing about a risk or issue or transference to transfer the risk to a third party, e.g. a cloud service provider.

Execution and management processes for a project

The implication of the execution phase requires the management of processes through the project to ensure success of the project and to manage the project's resources and to avoid chaos during the project.

- Processes to manage throughout the execution phase, including:
  - time, e.g. a process for recording time against tasks, timesheets, updated project plans
  - cost, e.g. identify each cost in the project, expenses, keep a central record of costs
  - quality, e.g. set quality targets, define how to measure quality, report on the quality level
  - change, e.g. requests for change, evaluate the feasibility, manage the approval of change
  - risks and issues, e.g. slippage of time or quality of work
  - acceptance, e.g. facilitate testing, document the results, request acceptance and approval.

Learning aim D: Undertake the closure of a project by reflecting on the success of personal performance and the project outcome

D1 Lessons learned from implementing an IT project

The concepts and processes of project management review.

- Scope of the lessons learned should cover:
  - project management skills, e.g. proper use of project management processes, understanding of particular roles and use of management documentation for analysis and progress management
  - behaviours applied during the project, e.g. time planning, communication and problem-solving skills.
- Understand relevant behaviours for project management, including:
  - time planning and management to complete all the different activities in an appropriate time and sequence, how and when feedback from others will be gathered
  - communication and literacy skills to follow and implement instructions appropriately, interpret documentation and communicate effectively with others, including the use of feedback from others in writing and orally
  - problem-solving skills, e.g. logical thinking, investigating the source of the problem, breaking down a problem into manageable chunks, and identifying one or more solution(s) to a problem
  - other behaviours and their impact on the project outcome, to include professionalism, etiquette, leadership, and taking responsibility for one's actions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate the principles and methodologies of IT project management as used in industry</td><td rowspan="2">A.D1 Evaluate, using appropriate definitions, the characteristics of different methodologies and structures applied in IT projects.</td></tr>
<tr><td>A.P1 Explain, using appropriate definitions, the characteristics of different methodologies applied in IT projects.
A.P2 Explain the project management structures applied in different IT projects.</td><td>A.M1 Compare, using appropriate definitions, the characteristics of different methodologies and structures applied in IT projects.</td></tr>
<tr><td colspan="2">Learning aim B: Carry out a project initiation for an IT project</td><td rowspan="4">BC.D2 Evaluate consistently and comprehensively at least two researched and realistic solutions to an IT problem on a given theme and justify, using logical chains of reasoning, a preferred solution.
BC.D3 Perform consistently and effectively appropriate project management processes to implement an IT-based project.</td></tr>
<tr><td>B.P3 Research with some inconsistencies an IT problem, based on a given theme and scope out at least two alternative solutions.
B.P4 Prepare with some inconsistencies a feasibility study on an IT project and select a preferred solution.</td><td>B.M2 Assess consistently at least two adequately researched solutions to an IT problem on a given theme and recommend a preferred solution.</td></tr>
<tr><td colspan="2">Learning aim C: Carry out the planning, execution, monitoring and controlling of an IT project, using an appropriate methodology</td></tr>
<tr><td>C.P5 Plan with some inconsistencies and/or omissions the implementation of an IT project.
C.P6 Execute with some inconsistencies and/or omissions the implementation of an IT project.
C.P7 Monitor and control with some inconsistencies and/or omissions the implementation of an IT project.</td><td>C.M3 Perform soundly and consistently appropriate project management processes to implement an IT-based project.</td></tr>
</table>

Pass	Merit	Distinction
Learning aim D: Undertake the closure of a project by reflecting on the success of personal performance and the project outcome		**D.D4** Demonstrate consistently good technical understanding and analysis of the project, including the effective application of relevant project management skills and behaviours.
D.P8 Explain how project management skills were used in the management of an IT project. **D.P9** Explain how relevant behaviours were applied during the management of an IT project.	**D.M4** Recommend improvements to the project management skills and behaviours applied during an IT project.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Learning aim: D (D.P8, D.P9, D.M4, D.D4)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- a variety of physical resources, dependent on the type of IT project they pursue. Many of these resources are detailed in the other units in the qualification
- workshops, laboratories and specialist software applications.

Learners would benefit from exposure to commercial project management software.

Learners may also need access to project simulation software.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate three different projects delivered using different project management methodologies as covered in the unit content. The evaluation will cover a comprehensive range of benefits and limitations of using a methodology based on the context. Learners will evaluate the structures used in the delivery of the project and how they play an important role in the management of the project, given the context. A supported judgement will be given that leads to a conclusion. For example, an Agile methodology may be chosen for a complex management tool for the banking industry because it is more flexible to use in a dynamic sector with unclear user requirements, and it offers shorter iterations of development and planning.

Overall, the evidence, such as a report, will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language (including definitions) throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will compare at least three different project management methodologies used to deliver projects. The comparison will cover the benefits and limitations of each, and give reasons why they might be used during the management of a project. For example, PRINCE2 is a structured project management methodology that focuses on product outputs resulting from the project. In Agile, the focus is also on product outputs following a short sprint or iteration that, unlike PRINCE2, provides greater opportunities to assess the direction of a project throughout the development life cycle. Learners will compare the different structures used in the IT projects.

Overall, the evidence will be logically structured, technically accurate (including definitions) and easy to understand.

For Pass standard, learners will explain the characteristics of and structures used in three IT projects delivered using different project management methodologies. For example, they will explain that Agile is a software development methodology where, in its initial stages, the users, business managers and IT staff discuss requirements of the project before development. They will describe the requirements of the project and document the outcome. The product should be designed and developed in a continuous phase.

Overall, the evidence will be well structured, with some use of appropriate technical language (including definitions), although there may be some inaccuracies with terms used. Some parts of the evidence may be considered in greater depth than others.

Learning aims B and C

For Distinction standard, learners will include at least two possible IT solutions to the given theme or an initial idea in their evidence. The comprehensive research evidence and feasibility study will provide at least two realistic alternative solutions to an IT problem. The evidence will be at a consistent breadth and depth. It will identify and evaluate the project risks and constraints and suggest viable methods of controlling the risks. For example, for a simulated IT project, learners might identify the lack of skilled resource in the development team as a risk and might identify the need to recruit an experienced developer to lead the development. They would also recognise that this initial cost would be offset if the project is successfully completed. A range of criteria will allow a good evaluation of the solutions and the justification of the preferred solution will be supported by logical chains of reasoning.

Learners' preferred solution or a simulated project will be implemented over the project life cycle using an appropriate methodology. Learners will perform consistent and effective project management processes using an appropriate methodology. For example, for a simulated IT project, learners might produce an initial software requirements specification that outlines the functional and non-functional requirements of the project. Using the Agile methodology, they would then produce user stories that facilitate planning of time and resources required to complete the work.

Overall, the evidence will be easy to read and understand by a third party. It will be logically structured and use technical terms with a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will cover at least two possible solutions to an IT problem in their research evidence. Each solution will be investigated consistently (to a similar breadth and depth) and most of them will be realistic. High-level evidence will be given, scoping out each alternative solution to the IT problem.

Learners will undertake a feasibility study on the potential solutions and will assess each of them in turn. The study will be supported by research evidence of consistent breadth and depth across the two solutions. The risks and constraints associated with each solution will have been given. Enough criteria will have been used in the assessment to make an informed recommendation for the preferred solution. For example, as part of a simulated IT project, learners might suggest that part of the project is outsourced to lower initial costs and satisfy the constraints of an inexperienced development team.

Learners' preferred solution or a simulated project will be implemented over the project life cycle using an appropriate methodology. Learners will perform soundly appropriate project management processes. For example, if following the waterfall methodology as part of a simulated project, learners would produce development tasks based on the functional and non-functional requirements that facilitate time and resource planning.

Overall, the evidence will be logically structured, technically accurate and easy to understand. However, learners may not fully appreciate the number of iterations required to scope out two different solutions.

For Pass standard, learners will research at least two potential solutions to an IT problem on a given theme. The research will be patchy in some areas, it may not support all the solutions given and at least one solution may not be realistic. The evidence will scope out the solutions and may include benefits, diagrams, storyboards, flow charts and other technical information.

The feasibility study will assess each of the alternative solutions in turn and cover the associated risks and constraints. The study will be supported by the research, although the depth and breadth of evidence will be inconsistent across the two solutions and the study will not contain enough criteria to make an informed decision on which solution to develop. A preferred solution will be selected. For example, as part of a simulated IT project, learners may have mistakenly suggested a project is feasible based on the amount of potential profit from the project, ignoring the lack of experience and resources available.

Learners will implement either their preferred solution or a simulated IT project through the life cycle stages of planning, executing, monitoring, controlling and using an appropriate methodology. They will deliver the project management processes such as planning, risk and issue management, and monitoring and controlling quality. They should suggest solutions to any problems that occur during the project. Although there will be evidence of a range of project management processes being used, there will be some inconsistencies and/or omissions in their use. For example, as part of a simulated IT project, learners' project plans may not be updated at appropriate times during the project and so was not used to monitor and control timely implementation of the project.

Overall, the evidence will be well structured, with some use of appropriate technical language, although there may be some inaccuracies with terms used. Some parts of the evidence may be considered in greater depth than others.

Learning aim D

For Distinction standard, learners will demonstrate effective project management skills and relevant behaviours throughout the project initiation and implementation (planning, execution and monitoring and control). For example, all work will be completed on time, the practical activities will be planned out in advance and problems encountered will be solved. Also, the lessons learned evidence will demonstrate a consistently good technical understanding and analysis of the project, and examples of where improvements could be made will be given.

Overall, the evidence will include a balanced view about the actions taken and project management processes applied. The report will be easy to read and understand by a third party and the correct and consistent use of technical IT language will be evident.

For Merit standard, learners will give examples in their evidence of where improvements could be made to the application of:

- project management skills, e.g. that additional progress reviews were required to monitor and control progress against time
- relevant behaviours, e.g. that problems needed to be better anticipated to prevent them from impacting on the project outcome.

Overall, the suggested improvements should be reasonable and practical and technical terminology used accurately.

For Pass standard, learners will produce evidence, such as a lessons learned report of around 300 words in length, which will explain:

- what project management skills were applied, such as using techniques and documentation to manage the project
- how behaviours were used, such as time management and planning to ensure the activity was completed within the appropriate time.

Overall, the evidence will be well structured, with some use of appropriate technical language, although there may be some inaccuracies with terms used. Some parts of the evidence may be considered in greater depth than others.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 3: Using Social Media in Business
- Unit 4: Programming
- Unit 6: Website Development
- Unit 7: Mobile Apps Development
- Unit 8: Computer Games Development
- Unit 11: Cyber Security and Incident Management
- Unit 13: Software Testing
- Unit 14: Customising and Integrating Applications
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 18: The Internet of Things.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used IT project management
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 10: Big Data and Business Analytics

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore how businesses and organisations use data and models to make decisions, develop strategy and improve performance.

Unit introduction

Businesses and organisations collect vast amounts of data from a wide range of sources about their operations and customers, and much of this data is unplanned and/or unstructured. The resulting data sets can be so large that they are now known as big data. For example, most retailers use ecommerce systems that can capture customer preferences and enable them to optimise their stock holdings, while individual data from smartwatches and wearable devices can be compiled to monitor and improve health and sports performance. Big data and data analytics are also used to improve many aspects of our lives, such as reviewing and optimising traffic flows, detecting terrorist plots and preventing cybercrime.

In this unit, you will investigate how and why organisations collect data and the methods they use to store and analyse it. You will explore a range of methods to present data for different audiences and purposes, and statistical methods used to analyse data. You will use software to analyse a data set to provide information that could inform business plans and improve profitability.

The analytical and problem-solving skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment.

This unit provides partial coverage to content from the Microsoft Azure Data Fundamentals Certification.

Learning aims

In this unit you will:

A Investigate the role of big data and business analytics to improve performance, for benchmarking and/or to trigger innovation in organisations

B Explore the statistical software tools and techniques used to analyse data in organisations

C Carry out analysis of statistical data to meet the needs of an organisation.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the role of big data and business analytics to improve performance, for benchmarking and/or to trigger innovation in organisations	**A1** Business information **A2** Types and storage of data **A3** Analysing big data	A presentation focusing on how business analytics can be used by organisations to inform decisions that improve performance, for benchmarking and how this may result in innovation.
B Explore the statistical software tools and techniques used to analyse data in organisations	**B1** Statistical techniques **B2** Probability distributions **B3** Mathematical modelling of data to find a goodness of fit	An informal report containing the results of learners' calculations and analysis of measured and supplied data, using appropriate software.
C Carry out analysis of statistical data to meet the needs of an organisation	**C1** Selecting data for analysis **C2** Evaluating a data set and presenting the outcomes	A formal report using software tools to analyse a data set for a given organisation and to present the outcome (visualisation).

Content

Learning aim A: Investigate the role of big data and business analytics to improve performance, for benchmarking and/or to trigger innovation in organisations

A1 Business information

The role of tools and systems in the decision-making process of an organisation.

- The reasons why organisations analyse data, including:
  - strategy planning and implementation, e.g. to identify individual customer behaviour, such as who buys what, when, where, how much, how, to identify customer trends and to target their market communications
  - improving departmental productivity, e.g. finance, marketing and sales, information technology, operations and supply chain management
  - product and/or service benchmarking, development and triggering innovation, e.g. to increase the volume of sales and/or turnover and to develop new or improved products and/or services as a result of analysing data.
- The purpose and use of transactional and analytical data to provide business information and support decision making.
- General challenges of analysing data, including:
  - high costs of design and implementation to gather, store and analyse the data
  - staff skills and training needs
  - data security compliance and maintenance.
- Legislative, ethical and security issues, including:
  - local current and relevant legislative issues
  - ethical issues, including individual and organisational rights and responsibilities, e.g. guaranteeing individual anonymity while maintaining the quality of data, access to personal and sensitive data
  - security of commercial and personal data, e.g. accidental or malicious loss, damage or corruption of data, password policy, data encryption, and maintenance of IT systems.

A2 Types and storage of data

The concepts of IT project requirement of data types and storage of data.

- Types of data, including:
  - qualitative data: descriptive information
  - quantitative data: numerical information
  - internal data: data created by the functions of the organisation, e.g. marketing, sales, production, customer service department and/or embedded electronic devices, e.g. sensors and actuators (via the Internet of Things (IoT))
  - external data: data that originate from outside the organisation, e.g. surveys, interviews, focus groups, mobile apps, website visits, cookies, loyalty card programs, online surveys.
- Storing data, including:
  - structured data: data in a fixed field in a record or file, e.g. data contained in relational databases and spreadsheets
  - unstructured data: data not in a relational database, e.g. text and/or email messages, photographs, web pages, business documents, data captured by sensors on IoT

- system-based factors, including
  - volume: the quantity of data that is generated
  - velocity: the speed of generation of data
  - variety: the mixture of data to be processed
- security of data, e.g. password protection, data encryption, secure processes, and sufficient maintenance of IT systems
- data warehouse
  - holds very detailed information on multiple subject areas
  - works to integrate all data sources together
- data mart, including
  - often holds only summarised data on one subject area, e.g. finance or sales
  - concentrates on integrating information from a given subject area or a set of source systems
  - stand-alone data mart: focuses on one subject area and it is not designed in a whole organisational context, e.g. manufacturing has their data mart, human resources theirs and so on
  - conformed data mart: facts and measures are categorised and described in the same way across multiple data marts, ensuring consistent reporting across the business.

- Accessing data, including:
  - sharing data across an organisation
  - ensuring that the right people have readily available access to
    - data
    - analytical software, e.g. spreadsheet, database, commercial statistical application, e.g. JMP®
    - data-management processes.

A3 Analysing big data

The challenges of analysing big data (large data sets) to aid businesses and organisations in making future decisions, including:

- implementing batch and streaming data processing as required, and ensuring the correct data is available for each system
- the need for high-level skills in using specialised software tools, e.g. JMP and applications for predictive analytics, data mining, text mining, forecasting and data optimisation to analyse large amounts of data
- online analytical processing (OLAP) technology to analyse multidimensional data quickly (manage volume, velocity, compatibility of data sets, accessing all data), e.g. to complete complex calculations, carry out 'what if' scenarios, produce reports in different formats
- ensuring that data is valid, accurate, current, relevant, sufficient.

A4 Types of business analytics

The concepts of the four stages (or levels) of business analytics:

- descriptive analytics (or data mining) analyses data to uncover patterns. It can use data in real time to give a current picture, e.g. using online activity to target products or services at individual customers
- diagnostic analytics uses techniques, including data mining to identify the reasons for past success and failure

- predictive analytics uses data mining and statistical modelling to analyse past and current data to identify potential challenges and opportunities for an organisation to make future forecasts
- prescriptive analytics uses data mining, statistical modelling and business forecasts to identify actions to be taken to improve performance.

Learning aim B: Explore the statistical software tools and techniques used to analyse data in organisations

B1 Statistical techniques

The statistical requirements of operations when analysing data in organisations.

- Routine operations, including:
  - discrete data, continuous data, ungrouped data, grouped data
  - presentation of data: bar charts, pie charts, histograms
  - use of industry-standard software (e.g. spreadsheets, dashboards) to present data in appropriate formats for audience and purpose
  - measures of central tendency: arithmetic mean, median, mode.
- Non-routine operations, including:
  - measures of dispersion: variance, standard deviation, range, interquartile and inter-percentile ranges
  - use of spreadsheet and industry-standard software to calculate measures of dispersion.

B2 Probability distributions

The use of probability distributions process.

- Routine operations, including:
  - normal distribution: shape, symmetry, mean.
- Non-routine operations, including:
  - areas under the normal distribution curve relating to integer values of standard deviation
  - use of industry-standard software, including spreadsheets and specialist software, e.g. JMP and MATLAB® to determine if data represents a normal distribution
  - comparison of the mean of two samples using software to carry out a t-test.

B3 Mathematical modelling of data to find a goodness of fit

The requirements of mathematical modelling of data in the IT project.

- Linear relationship between independent and dependent variables, scatter diagrams, approximate equation of line of regression $y = mx + c$ graphically.
- Use of spreadsheet and industry-standard software to calculate an equation of the line of regression and correlation coefficient.
- Use of spreadsheet and industry-standard software to identify the most appropriate type of regression line for a non-linear relationship.

Learning aim C: Carry out analysis of statistical data to meet the needs of an organisation

C1 Selecting data for analysis

The selection of a suitable data set to produce information to support an organisational decision.

The process will involve:

- identifying the objectives of the analysis and framing a clear, specific, well-defined question to identify what you want to know
- defining the system requirements
- defining other factors to be considered, e.g. constraints, access, security issues, e.g. data protection and reliability
- identifying valid, accurate, current, relevant and sufficient big data.

C2 Evaluating a data set and presenting the outcomes

Software techniques used to analyse data sets for a defined audience or purpose.

- Preparation of the data for analysis, where data should be:
  - 'clean' – the data is consistent, accurate and complete
  - 'formatted' – the data is in a standard format that most commercial software is capable of interpreting, and suitable for data interchange and transformation.
- Selecting appropriate programming and scripting languages for manipulating structured and unstructured data (e.g. SQL, Python, R).
- Use of industry-standard software and cloud-based resources (e.g. MS Azure Data Services, Amazon Web Services) to analyse the structured and unstructured data to produce appropriate reports for different audiences and purposes.
- The need for the outcomes of the analysis to be:
  - valid: conclusions and recommendations correctly drawn from the analysis of the data set
  - accurate: values are exact and correct
  - relevant: conclusions and recommendations address the initial question(s).
- Presentation of the outcomes from the data set analysis in an appropriate format for the audience and purpose, including:
  - the ability to convey intended meaning, e.g. written and verbal
  - graphical and numerical data, e.g. tables, charts, dashboards
  - recording documentation, reports, visual aids for presentation use; verbal communication requirements (one-to-one and group informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, and avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Investigate the role of big data and business analytics to improve performance, for benchmarking and/or to trigger innovation in international organisations		**A.D1** Evaluate how an organisation can use analytics to improve performance, benchmark and/or innovate.
A.P1 Explain how an organisation can use analytics to improve performance, benchmark and/or innovate.	**A.M1** Compare how an organisation can use analytics to improve performance, benchmark and/or innovate.	
Learning aim B: Explore the statistical software tools and techniques used to analyse data in organisations		**B.D2** Evaluate the correct synthesis and accurate application of routine and non-routine statistical, and probability operations using calculations and appropriate software to solve problems.
B.P2 Solve problems for a data set involving routine central tendency, dispersion and probability distribution operations, using software. **B.P3** Solve problems for a data set involving routine linear regression operations, using software.	**B.M2** Solve problems accurately for a data set involving routine and non-routine central tendency, dispersion and probability distribution operations, using software. **B.M3** Solve problems accurately for a data set involving routine and non-routine regression operations, using software.	

Pass	Merit	Distinction
Learning aim C: Carry out analysis of statistical data to meet the needs of an organisation		
C.P4 Prepare an appropriate raw data set to meet the needs of an organisation. **C.P5** Analyse, using software, the data set by applying routine statistical, probability and mathematical operations. **C.P6** Present straightforward conclusions and recommendations from the analysis of a data set to meet the needs of an organisation.	**C.M4** Prepare effectively an appropriate raw data set to meet the needs of an organisation. **C.M5** Analyse accurately, using software, the data set by applying routine and non-routine statistical, probability and mathematical operations. **C.M6** Present concise and valid conclusions and recommendations from the accurate analysis of the data set that are fit for different audiences and purpose to meet the needs of an organisation.	**C.D3** Present concise, valid and relevant conclusions and recommendations from an accurate evaluation of the effectively cleansed and formatted data set that are fit for different audiences and purpose to meet the needs of an organisation.

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.P3, B.M2, B.M3, B.D2)

Learning aim: C (C.P4, C.P5, C.P6, C.M4, C.M5, C.M6, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- a wide range of research resources, largely text and internet based. There are many free-to-use large data sets available
- at least two different pre-selected data sets (one for learning aim B, the other for learning aim C)
- industry standard software, such as spreadsheets and specialist software, e.g. JMP, MATLAB® and access to sufficient secure storage space to complete the analysis.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will present a balanced evaluation of the reasons why organisations use business analytics and the benefits that they may bring, drawing comparisons between the uses in different organisations. They will detail the ethical and legislative factors that govern the gathering of, access to and storage of data. For example, they will compare requirements stated in local data protection legislation (plus amendments) and similar European legislation such as the General Data Protection Regulation (GDPR). Learners will evaluate the types of data and sources available to organisations. For example, they will distinguish between the benefits and challenges of using structured and non-structured, internal and external, and qualitative and quantitative data. Learners will evaluate the infrastructure challenges faced by organisations that use and process big data. For example, they will justify the reasons for infrastructure choices based on the volume, variety and velocity of data. Learners will evaluate the use of different types of business analytics, the type of information they may generate and detail practical ways in which organisations may use that information. For example, they will make valid, accurate and relevant judgements on the usefulness of descriptive, diagnostic, predictive and prescriptive analytics and give examples of where each could be used in a real-world application. Learners will detail the benefits and challenges to organisations that may arise from the collection, storage and analysis of organisational data, with particular reference to big data. For example, they will extend their evaluation of benefits and challenges beyond the legal and ethical issues to others such as deliberate attacks on systems (hacking), inadequate password protection or with encryption, insecure processes, and/or lack of IT system maintenance.

Overall, the evidence will be logically structured and use correct technical terms with a high standard of written language, including the consistent use of correct grammar and spelling.

For Merit standard, learners will compare the reasons why organisations use big data and business analytics, as well as the benefits and challenges that they may bring. They will compare the ethical and legislative factors that govern the gathering of, access to and storage of data. For example, they will describe the impact of data protection legislation (plus amendments) on different organisations. Learners will detail alternative types of data and sources available to organisations and how they may be used. For example, they will compare structured and non-structured, internal and external, and qualitative and quantitative data and why organisations may (or may not) decide to use each. Learners will compare the infrastructure challenges faced by organisations that

use and process data, including big data. For example, they will compare the reasons for infrastructure choices based on the volume, variety and velocity of data. Learners will define the use of different types of business analytics, the type of information they may generate and how organisations may use that information.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will explain why organisations use big data and business analytics, as well as the benefits and challenges that they may bring. They will identify and explain ethical and legislative factors that govern the gathering of, access to and storage of data. Learners will identify alternative types of data and sources available to organisations and how they may be used. They will identify and explain infrastructure challenges faced by organisations that use and process data, including big data. Learners will define different types of business analytics, the type of information that may be generated and how organisations may use that information. They will explain the benefits and challenges to organisations that may arise from the collection, storage and analysis of data.

Overall, the evidence will be logically structured. It may be basic in parts, for example the range of data types may not be extensive. The evidence may contain minor inaccuracies or omissions, for example the legislation may not be the most current version.

Learning aim B

For Distinction standard, learners will evaluate the correct synthesis (combining elements into a coherent entity) and accurate application of routine and non-routine statistical, and probability operations using industry standard software to solve problems. For example, they will tabulate grouped data and generate fully annotated pie charts, bar charts and histograms. Learners will accurately calculate representative values for central tendency and evaluate the usefulness of the values in relation to the distribution of data. They will accurately calculate variance, standard deviation, range, interquartile and inter-percentile values of normally distributed data and explain the meaning of each. Learners will carry out a t-test on two sets of data and evaluate the relevance of the result.

They will use experimental data to accurately determine the equation of linear regression and correlation coefficient. They will compare the predicted value of the dependent variable with the value obtained from the graph for a non-measured value, in relation to the value of the correlation coefficient. They will justify the choice of regression type for a non-linear relationship, such as a power relationship.

Overall, the evidence will be easily understood by a third party with a mathematical background. There will be correct use of mathematical terminology and application of relevant units. Learners will work to a specified numerical accuracy, as determined by their assessor, or that is appropriate for solving their chosen problems, through the use of appropriate significant figures or decimal places. Small and large numerical values will be correctly presented in an appropriate format, i.e. mathematical notation or standard form. All calculations will be fully documented and the reasons for the choice of method will be given.

For Merit standard, learners will accurately solve problems for a data set involving routine and non-routine central tendency, dispersion and probability distribution operations, using industry standard software. For example, they will tabulate grouped data and generate annotated pie charts, bar charts and histograms accurately. Learners will accurately calculate representative values for central tendency (mean, mode and median). They will calculate variance, standard deviation, range, interquartile and inter-percentile values of normally distributed data. Learners will carry out a t-test on two sets of data and draw a simple conclusion from the result.

They will use experimental data to accurately determine the equation of the linear regression and correlation coefficient, predicting the value of the dependent variable for a non-measured value. Learners will compare the value with the corresponding value from the graph. They will select and use a suitable type of regression for a non-linear relationship, such as a power relationship. Each calculation will be supported by a brief explanation of the method used.

Overall, the numerical work will be to an appropriate degree of accuracy, as specified by the assessor or appropriate for the chosen problems being solved, and the methods selected will be used correctly. Solutions will contain an explanation of the process, which will be logically structured and the correct mathematical terminology and relevant units will be used. There may be a limited number of minor errors or omissions in non-routine operations. For example, when evaluating a data set, learners may determine the mean and standard deviation for a sample and find a degree of correlation between samples, but not draw conclusions from the values.

For Pass standard, learners will solve problems for a data set involving routine central tendency, dispersion and probability distribution operations, using industry standard software. For example, they will tabulate data and generate pie charts, bar charts and histograms. Learners will calculate representative values for central tendency (mean, mode and median). They will calculate variance, standard deviation, range, interquartile and inter-percentile values of normally distributed data. Learners will carry out a t-test on two sets of data.

They will use software to solve problems for a data set involving routine linear regression operations. Learners will use experimental data to determine the equation of linear regression and correlation coefficient. They will use a regression technique for a non-linear relationship, such as a power relationship.

Overall, the evidence will be logically structured and the correct methods will be used. The evidence may contain some arithmetic errors that 'carry through', for example the value of the mean from a data set may be incorrect but that value will be used correctly to find the standard deviation. Minor errors and omissions are acceptable. For example, the titles of axes on a histogram may be missing units. There will be an appreciation of correct use of units but there may be errors or inconsistency in their application. Learners will include evidence of simple checks to determine if numerical answers are ’reasonable'.

Learning aim C

For Distinction standard, learners will evaluate the outcomes and produce accurate, valid and relevant judgements from the analysis of the effectively cleansed and formatted data set. They will formulate a clear, specific, well-defined question to identify what they want to know. Learners will select methods to generate valid, accurate and relevant information. The analysis must include appropriate and accurate presentation of data, calculations of central measures, dispersion and probability functions, comparison of data sets and regression.

Learners' presentation will be fit for two different audiences and a purpose to meet the needs of an organisation. For example, they will clearly define the purpose of the analysis and the intended audiences.

Overall, the evidence will be easily understood by a third party with a mathematical background. There will be correct use of mathematical terminology and application of relevant units. Learners will work to specified numerical accuracy, as determined by the assessor, or that is appropriate in order for solving their chosen problems, through the use of appropriate significant figures or decimal places. Small and large numerical values will be correctly presented in an appropriate format, i.e. mathematical notation or standard form.

For Merit standard, learners will prepare effectively a large raw data set so that the analysis can be carried out to meet the needs of an organisation, for example by removing the vast majority of the unwanted data and formatting the units, such as currency or percentages, consistently. They will formulate a well-defined question to identify what they want to know.

Learners will use industry standard software to analyse the data set by applying routine and non-routine statistical, probability and mathematical operations accurately. For example, they will present data, calculate central measures, dispersion and probability functions, compare data sets and use regression techniques.

Learners will present concise conclusions and recommendations from the accurate analysis of the data set which are fit for two different audiences and a purpose to meet the needs of an organisation. For example, the audience for a presentation could be a technical management meeting, and the other a shareholders' report.

Overall, the numerical work will be to an appropriate degree of accuracy, as specified by the assessor, or appropriate for the chosen problem being solved, and the methods selected will be used correctly. Solutions will be logically structured and the correct mathematical terminology and relevant units will be used. There may be a limited number of minor errors or omissions in non-routine operations. For example, when evaluating a data set, learners may determine the mean and standard deviation for a sample and find a degree of correlation between samples, but not draw conclusions from the values.

For Pass standard, learners will prepare the large data set (at least 500 records) by cleaning and formatting it, for example by removing some unwanted data and formatting some of the units, such as currency values. They will state the purpose of the analysis and the intended audience. They will formulate a question to identify what they want to know.

Learners will use industry standard software to analyse the supplied data set by applying routine statistical, probability and mathematical operations. For example, they will present data, calculate central measures (mean, mode and median) and calculate the line of best fit of a linear relationship.

Learners will present straightforward conclusions and recommendations from the analysis of the data set that are fit for audience and purpose to meet the needs of an organisation.

Overall, the evidence will be logically structured and the correct analytical methods will be used, although the presentation may not meet the needs of the audience and/or purpose. The evidence may contain some arithmetic errors that 'carry through'. The presentation may contain minor inaccuracies or omissions, for example inadequate preparation of the data may result in inaccurate outcomes (garbage-in-garbage-out). There will be an appreciation of correct use of units but there may be errors or inconsistency in their application. Learners will include evidence of simple checks to determine if numerical answers are 'reasonable'.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 11: Cyber Security and Incident Management
- Unit 14: Customising and Integrating Applications
- Unit 18: The Internet of Things
- Unit 19: Enterprise in IT.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used in big data and business analytics
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 11: Cyber Security and Incident Management

Level: 3
Unit type: Internal set assignment
Guided learning hours: 120

Unit in brief

Learners study cyber security threats and vulnerabilities, the methods used to protect systems against threats and how to plan for and manage security incidents.

Unit introduction

Our increasing reliance on computer systems and the data they contain makes us vulnerable to attacks from cyber criminals, and to the loss of these systems if there is an accident or a natural disaster. As IT system security is improved, more sophisticated methods of attack are developed, and it is important that organisations have robust plans in place to deal with a cyber security incident before it occurs. All IT professionals require a good understanding of the current threats to systems, how to apply appropriate and effective protection methods and how to manage a cyber security incident.

Countries throughout the world are accelerating efforts to address cyber security risks to their public-safety and mission-critical communications networks. In this unit, you will examine the many different types of cyber security attacks, the vulnerabilities that exist in networked systems and the techniques that can be used to defend an organisation's networked systems. You will investigate the techniques used to assess risks and ways of planning to deal with the results of a cyber security incident and recover systems following an incident. You will examine scenarios, carry out risk assessments and prepare protection plans before protecting networked systems. You will also examine evidence from cyber security incidents and relevant security documentation, using the evidence to make recommendations for improvement.

As IT systems evolve, there is an increasing need for IT professionals to protect networked systems and the information they contain, while providing enhanced features and benefits for organisations, customers and individuals.

Assessment

This unit has a set assignment. Learners must complete a Pearson Set Assignment Brief.

Learning aims

In this unit you will:

A Understand cyber security threats, system vulnerabilities and security protection methods

B Explore the security implications of networked systems

C Develop a cyber security protection plan for a specified organisation

D Examine procedures to collect forensic evidence following a security incident.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand cyber security threats, system vulnerabilities and security protection methods	**A1** Cyber security threats **A2** System vulnerabilities **A3** Legal responsibilities **A4** Physical security measures **A5** Software and hardware security measures	This unit is assessed through a Pearson Set Assignment.
B Explore the security implications of networked systems	**B1** Network types **B2** Network components **B3** Networking infrastructure services and resources	
C Develop a cyber security protection plan for a specified organisation	**C1** Assessment of computer system vulnerabilities **C2** Assessment of the risk severity for each threat **C3** A cyber security plan for a system **C4** Internal policies **C5** External service providers	
D Examine procedures to collect forensic evidence following a security incident	**D1** Forensic collection of evidence **D2** Systematic forensic analysis of a suspect system	

Content

Learning aim A: Understand cyber security threats, system vulnerabilities and security protection methods

A1 Cyber security threats

Apply an understanding of cyber security threats that impact on organisations in a range of sectors and vocational-based scenarios.

All systems are vulnerable to attack from external and internal threats.

- How internal threats occur, including:
  - employee sabotage and theft, including of physical equipment or data, and damage such as fire, flood, power loss, terrorism or other disaster
  - unauthorised access by employees and other users to secure areas and administration functions, including security levels and protocols
  - weak cyber security measures and unsafe practices, including security of computer equipment and storage devices, security vetting of visitors, visiting untrustworthy websites
  - accidental loss or disclosure of data, including poor staff training and monitoring.
- How external threats function, including:
  - malicious software (malware), including spyware, adware, ransomware; viruses, including worms, rootkits and Trojans
  - hacking, including commercial, government, individuals
  - sabotage, including commercial, government, terrorism, individuals
  - social-engineering techniques used to obtain secure information by deception.
- The impact of a credible threat is likely to result in some form of loss, such as:
  - operational loss, including manufacturing output, service availability and service data
  - financial loss, including organisational, compensation and legal liability
  - reputation loss, including lack of service and employee or customer information
  - intellectual property loss, including new product design or trade secret.
- The impact level of a successful attack on an organisation is determined by the value of the loss, and that the value may not always be a monetary one.
- Know that cyber security threats vary over time and cyber security organisations provide regular updates on the current and changing threat landscape.

A2 System vulnerabilities

Apply an understanding of system vulnerabilities that impact on organisations in a range of sectors and vocational-based scenarios.

- Different types of computer and/or system are exposed to different threats and they contain different vulnerabilities. Possible vulnerabilities include:
  - network, including firewall ports and external storage devices
  - organisational, including file permissions or privileges, password policy
  - software, including from an untrustworthy source, downloaded software, illegal copies, SQL injection and new zero-day exploits
  - operating system, including unsupported versions, updates not installed
  - mobile devices reliant on Original Equipment Manufacturers (OEMs) to update system software

  - physical, including theft of equipment, Universal Serial Bus (USB) storage devices with sensitive data, collection of passwords and other information by social-engineering methods
  - process of how people use the system, including leaks and sharing security details
  - security implications of cloud computing and of the Internet of Things (IoT) devices.
- Where to find up-to-date sources of information on specific known hardware and software vulnerabilities.
- Attack vectors, including: Wi-Fi, Bluetooth®, internet connection, internal network access.

A3 Legal responsibilities

Apply an understanding of the legal responsibilities of organisations in a range of sector and vocational-based scenarios with regards to cyber security.

- International and regional legislation and regulations for data protection.
- Computer misuse policy/act and amendments, its definitions of illegal practices and applications.
- Telecommunications legislation, requirements to allow companies to monitor an employee's communication and internet use while at work.
- Fraud policy legislation-requirements to deal with services using IT-based methods to steal information for fraudulent purposes
- International regulations dealing with health and safety at work and the rights and duties of employers, employees at work.

A4 Physical security measures

Apply an understanding of physical security measures that organisations can apply in a range of sectors and vocational-based scenarios.

- Use and effectiveness of physical security measures, including:
  - site security locks, card entry, biometrics, closed-circuit television (CCTV), security staff, alarms, protected cabling and cabinets
  - data storage, data protection and backup procedures, including planned automated backup, on- and off-site data storage and cloud storage.

A5 Software and hardware security measures

Apply an understanding of security measures that organisations can apply in a range of sectors and vocational-based scenarios.

- Use and effectiveness of software and hardware security measures, including:
  - antivirus software and detection techniques, including virus signatures, heuristics techniques used to identify potentially suspicious file content, techniques for dealing with identified threats
  - software and hardware firewalls and the filtering techniques they use, including:
    - packet filtering and inspection
    - application layer awareness
    - inbound and outbound rules
    - network address

  - user authentication
    - user login procedures
    - strong password
    - text and graphical password
    - biometric authentication
    - two-step verification
    - security tokens, including USB-based and near field keys
    - knowledge-based authentication, including question and response pairs
    - Kerberos network authentication for Windows® and Linux®-based operating systems
    - certificate-based authentication
  - access controls and the methods to restrict users' access to resources, including applications, folders, files and physical resources
  - trusted computing.
- Purpose and uses of encryption, including:
  - safe password storage
  - digital rights management (DRM)
  - file, folder, disc encryption
  - communications encryption
    - built into devices, including smartphones and tablets
    - The Onion Router (Tor)
    - virtual private networks (VPNs)
    - digital certificates and certificate authorities
    - Hypertext Transfer Protocol Secure (HTTPS)
    - public/private keys.
- Precautions that can be taken to protect a wireless local area network (WLAN) from unauthorised access, including:
  - MAC address filtering and hiding the service set identifier (SSID)
  - wireless encryption – Wired Equivalent Privacy (WEP), Wi-Fi Protected Access 2 (WPA2) and Wi-Fi Protected Setup (WPS), mitigating known wireless vulnerabilities
  - consideration of security issues during network and system design to ensure security is built-in from the development stage.

Learning aim B: Explore the security implications of networked systems

B1 Network types

The features and implications for individuals and organisations of selecting networks for different purposes.

- Applications and features of networks:
  - local area network (LAN), WLAN, wide area network (WAN), storage area network (SAN), personal area network (PAN)
  - intranet, extranet, internet, cloud
  - wired and wireless integration.
- Applications and features of network topologies:
  - physical topologies, including star, extended star, hierarchical, wireless mesh, ad hoc (mix of wired and wireless for bring your own device (BYOD))
  - logical topologies, including Ethernet standards for wired and wireless (802 family).

- Applications and features of network architecture:
  - peer to peer
  - client/server
  - thin client.
- Modern trends, including applications and features of: virtualisation, cloud computing, BYOD, software-defined networking (SDN), storage-defined networks and the IoT.
- Be able to interpret and amend network schematic diagrams using suitable software.

B2 Network components

The features and implications for individuals and organisations of connecting devices to form a network.

- Application and features of hardware components, including:
  - end-user devices, including mobile
  - connectivity devices, including switches, routers, access points, multifunctional devices, USB hubs and modems
  - connection media, including cable, wireless (Wi-Fi, Bluetooth®, and infrared (IR)), fibre and Li-Fi.
- Applications and features of external media and storage, including flash drives and optical media.
- Applications and features of software components, including:
  - network and device operating systems
  - network monitoring, management and troubleshooting tools, including performance monitor, events and logs viewer, vulnerability scanners and packet sniffers
  - network applications, including database, document management and network discovery tools.

B3 Networking infrastructure services and resources

The application of network services and the impact these have on organisations.

- Application and function of:
  - Transmission Control Protocol/Internet Protocol (TCP/IP)
  - ports
  - packets
  - network address translation (NAT), including the structure of IPv4 and IPv6 addressing and RFC 1918 private addresses.
- Application of network operating systems, including domains and sub-domains.
- Application of network devices to configure networks, including network segmentation.
- Function and application of network infrastructure services, including:
  - domain name system (DNS)
  - directory services (DS), including active directory, open directory, OpenLDAP
  - authentication services
  - Dynamic Host Configuration Protocol (DHCP)
  - routing
  - remote access services.

- Function and application network services and resources:
  - file and print services
  - web, mail and communications services.

Learning aim C: Develop a cyber security protection plan for a specified organisation

C1 Assessment of computer system vulnerabilities

Understand how to assess vulnerabilities of an organisation's computer system in different scenarios.

Understand:

- the types and uses of tools and methods to assess the vulnerabilities in computer systems, including port scanners, registry checker, website vulnerability scanners, vulnerability detection and management software, and assessing user vulnerabilities
- the purpose of an independent third-party review of a system and network designs before implementation
- the applications and features of penetration testing for common threats, those in the Open Web Application Security Project (OWASP) top 10.

C2 Assessment of the risk severity for each threat

Understand how to assess the risk severity of an organisation's computer system in different scenarios.

- A risk is a threat that could result in some form of loss at some point in time.
- Risk severity = probability of the threat occurring × expected impact level/value of the loss.
- Measures for risk severity include:
  - risk severity = low, medium, high and extreme
  - probability of the threat occurring = unlikely (approximately every year), likely (approximately every week or month) and very likely (approximately once or more a day)
  - impact level/value of the loss = minor, moderate and major.
- Be able to use the following risk severity matrix:

Probability of threat occurring	Very likely	Medium	High	Extreme
	Likely	Low	Medium	High
	Unlikely	Low	Low	Medium
		Minor	Moderate	Major
		Impact level/value of the loss		

- Risk assessment approach:
  - risk assessments are carried out during system design (review) and at regular intervals during operation (audit) and following a security breach, as threats are constant and ever changing
  - a risk assessment method will:
    - identify possible threats and assess the probability of different threats occurring
    - assess the vulnerabilities of a computer-networked system to specific threats
    - assess the impact level/value of the potential loss
    - determine the risk severity (low, medium, high and extreme).

C3 A cyber security plan for a system

The purpose and development of a cyber security plan for an organisation in different scenarios.

A plan for a networked system, including:

- cyber security protection measures to be taken (actions) for the most severe (medium, high and extreme) risks with the largest impact level/loss value and that are most likely to occur, to include:
  - hardware protection measures, including firewalls, routers, wireless access points
  - software protection measures, including anti-malware, firewall, port scanning, access rights and information availability
  - physical protection measures, including locks, CCTV, alarms, data storage and backups
  - alternative risk management measures, including risk transfer to a third party (commissioning a service provider), risk avoidance by stopping an activity and risk acceptance
- a justification about how each planned protection measure would protect the system from attack
- an overview of any technical and financial constraints
- an overview of legal responsibilities
- an overview of usability of the system, including the degree to which security restrictions impact on the efficiency of the system in terms of the ease of completing tasks and the user experience
- outline cost–benefit analysis of implementing the protection measures
- test plan to check that the protection measures work as intended, including the test description, expected outcome, and possible further action following the test.

C4 Internal policies

Understand the internal policies that affect different organisations.

- The purpose and content of general security-related IT policies and their effectiveness, including:
  - understanding the requirements to prepare a cyber security policy using the Plan-Do-Check-Act loop derived from part of the International Organisation for Standardisation (ISO) 27001:2013
  - organisation policies and their application, including policies on internet and email use, security and password procedures, staff responsibilities, staff IT security training
  - security audits and their application to check compliance against policies
  - backup policy – selection of data, methods (full and incremental), frequency and storage
  - data protection policy – to ensure organisational compliance with the relevant legislation.

- The purpose and content of an incident response policy and associated procedures:
  - assembling the Computer Security Incident Response Team (CSIRT), roles in the team, including team leader, incident lead, associate members
  - incident reporting procedures, including what constitutes a security incident, and how to report it and to whom
  - initial assessment of the incident, including identifying if this is a real incident, the type of attack and its severity
  - communicating the incident to the CSIRT and other relevant individuals
  - containing the damage and minimising the risk
  - protect people's safety
  - protect sensitive data and other data, protecting the most valuable first
  - protect hardware and software
  - minimise disruption to computing resources
  - identifying the type and severity of the compromise, including the nature of the attack, its intent, its origin and the systems and files that have been compromised
  - protecting evidence and creating backups for evidence and data recovery, including the removal and storage of original hard disks
  - notifying external agencies, if appropriate, and discussing options with legal representatives, contact external agencies such as law enforcement, external security and virus experts
  - recovery of systems and identification of the point in time when the compromise occurred and restore backups from before that point in time
  - compile and organise incident documentation, including documentation created by the CSIRT identifying the details of the breach and actions taken
  - know the importance of preserving and collating documentation that may be needed to prosecute offenders
  - review outcomes to update policies and improve training.
- Topics typically covered in a disaster recovery plan and their purpose:
  - identification of critical systems, definitions of recovery time objective (RTO) and recovery point objective (RPO)
  - prevention, response and recovery strategies for critical systems, including
    - people responsible
    - facilities and equipment required
    - data backup location and format
    - network connectivity and bandwidth
    - suppliers of equipment and people
  - definition of recovery procedures for each critical system
  - disaster recovery plan structure following ISO 27031/24762 or other relevant international equivalents, including
    - introduction
    - roles and responsibilities
    - incident response procedures
    - activating the disaster recovery plan
    - procedures to be followed.

C5 External service providers

Understand the issues associated with external service providers.

- External service provider (ESP) agreements will include:
  - cloud
  - hardware
  - software.
- Implications of ESP agreements, including:
  - legal ownership and jurisdiction, including geographical location, data movement across borders, procedures when an agreement ends
  - security protection, including data security obligations, privacy, encryption, liability for data breaches, liability for data loss or damage (accidental or deliberate), disaster recovery procedures
  - dispute resolution, including statutory requirements, and problems encountered by data and processing residing in multiple jurisdictions.
- Many or all of these points are covered by the data protection laws.

Learning aim D: Examine procedures to collect forensic evidence following a security incident

D1 Forensic collection of evidence

Understand how to collect evidence using different forensic tools.

- Forensic collection of evidence following a security incident and its purpose.
- Desktop forensics:
  - meeting requirements for desktop forensics, including
    - confiscation of devices
    - taking an image of the system
    - using a forensic analysis tool
    - reviewing files and settings
    - reviewing system logs
    - reviewing user activity
    - malware analysis and alerts
  - the challenges of live forensics
    - changing data in situ
    - recovering corrupted data and preventing data corruption
    - capturing data in active memory
    - losing temporary files.
- Network forensics:
  - agreeing a network-testing methodology with forensic supervisory and investigatory authority
  - scanning of local infrastructure
    - ensuring permission is granted
    - ensuring that testing protocol will not disrupt a live system
    - passive and active analysis tools
  - reviewing and analysing firewalls and infrastructure devices, including switch, router, wireless access point, client or server logs
  - analysing malware activity and alerts.

D2 Systematic forensic analysis of a suspect system

Understand the features of a system forensic report for different organisations.

- Requirements for maintaining an accurate record made at the time, or as soon after the incident as possible.
- Retaining snapshots of the system.
- Requirements for the recording of all findings and considering how reliable the evidence is.
- Requirements for the recording of any alterations that have been intentionally and unintentionally imposed by the investigator.
- Requirements for the creation of visual evidence of findings.
- Ensuring the evidence is relevant and not a false positive.
- Evaluation of the findings to determine whether or not they:
  - provide evidence of a crime and/or an incident
  - show that the system has been externally and/or internally compromised
  - strongly support one possible cause more than other possible causes.
- Make recommendations to prevent security incidents from reoccurring in the future, including improvement(s) to the:
  - content of cyber security documentation (policies and/or agreements)
  - adherence of cyber security documentation (policies and/or agreements)
  - security protection measures (physical, software and/or hardware).

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Understand cyber security threats, system vulnerabilities and security protection methods</td><td rowspan="6">AB.D1 Evaluate the effectiveness of the measures used to protect organisations from cyber security threats while taking account of the legal requirements.</td></tr>
<tr><td>A.P1 Explain the different cyber security threats that can affect the IT systems of organisations.
A.P2 Explain the system vulnerabilities that can affect the IT systems of organisations.
A.P3 Explain how organisations can use physical, software and hardware security measures to counteract security threats.</td><td>A.M1 Assess the impact that cyber security threats can have on organisations' IT systems while taking account of the legal requirements.</td></tr>
<tr><td colspan="2">Learning aim B: Explore the security implications of networked systems</td></tr>
<tr><td>B.P4 Explain how different network types and components can be secured.
B.P5 Explain how cyber security impacts networking infrastructure and resources.</td><td>B.M2 Analyse the security implications of different networked systems.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a cyber security protection plan</td><td rowspan="4">CD.D2 Evaluate the cyber security plan, including its impact on internal policies and external service providers.</td></tr>
<tr><td>C.P6 Perform a risk assessment of system vulnerabilities.
C.P7 Produce a cyber security plan for an organisation's IT system.</td><td>C.M3 Justify the choice of security measures used to defend the IT systems of an organisation.</td></tr>
<tr><td colspan="2">Learning aim D: Examine procedures to collect forensic evidence following a security incident</td></tr>
<tr><td>D.P8 Explain the forensic procedures for collection of evidence following a security incident.</td><td>D.M4 Analyse how forensic procedures are implemented on a suspect system.</td></tr>
</table>

Essential information for assignments

This unit is assessed using a Pearson Set Assignment Brief. A set assignment must be used to assess learners

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to IT systems typically found in schools, colleges, and offices such as:

- personal computers
- office productivity applications, e.g. word processing, databases, spreadsheets
- network connectivity
- internet access.

There are no additional specialist resources needed for this unit.

Essential information for assessment decisions

Throughout the unit, learners will show individuality of thought, independent collection, collation and judgement of evidence.

The name and details of the organisation will be given to learners in the set assignment.

Learning aims A and B

For Distinction standard, learners will produce an evaluation on the effectiveness of the measures used to protect organisations from cyber security threats and the implications while taking account of the legal requirements. Learners will apply knowledge and understanding of cyber security in unfamiliar scenarios in order to identify common and uncommon risks, and use an extended range of security protection measures to comprehensively secure an existing networked system.

The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary, which supports a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will assess the impact that cyber security threats can have on organisations' IT systems, while taking account of the legal requirements.

Learners will present a reasoned and well-explained analysis based on the security implications of different networked systems.

The analysis will explore the impact the identified implications will have on the organisation.

The analysis will be balanced and supported by clear examples.

The evidence must be technically accurate and demonstrate good-quality written or oral communication.

Learners are able to apply knowledge and understanding of cyber security in unfamiliar scenarios in order to identify common and uncommon risks and use a range of security protection measures to comprehensively secure an existing networked system. They can give a valid justification for their design. Learners can design tests for a range of security procedures.

Learners are able to analyse some complex forensic evidence related to security incidents to produce coherent and convincing conclusions, together with alternative possibilities. They are able to identify a range of security weaknesses in a given scenario and make valid, realistic and mainly justified suggestions for improvement.

Learners will mainly use appropriate technical language consistently to communicate their ideas.

For Pass standard, learners will provide explanations on cyber security threats, system vulnerabilities and how to counteract them.

They will also explain how different network types and components can be secured, as well as how cyber security impacts networking infrastructure and resources.

Learners should apply their knowledge and understanding of cyber security in unfamiliar scenarios in order to identify common risks and use familiar security protection measures to improve the security of an existing networked system.

Learners will use some appropriate technical language to communicate their ideas.

Learning aims C and D

For Distinction standard, learners will draw on their knowledge to produce an evaluation of a cyber security plan, including its impact on internal policies and external service providers. Learners will also evaluate the impact forensic investigations can have on an organisation.

The evaluation will be informed by a balanced, wide-ranging review of the security plan and the impact on organisations of undergoing a forensic investigation into their IT systems.

Learners will use appropriate technical language consistently to communicate their ideas.

For Merit standard, learners will provide a clear, accurate and well-balanced analysis of how forensic procedures are implemented on suspect systems. They should consider all forensic procedures in the unit content as a guide. Learners should also provide clear justifications of security measures used to defend the IT systems of a given organisation.

For Pass standard, learners will carry out a risk assessment of the system vulnerabilities of a given organisation. They will create a cyber security plan for the given organisation as well as explore the forensic procedures for collection of evidence during a forensic investigation.

Learners will explore how forensic procedures can be used to collect evidence on a suspect system.

Assessment controls

Time: this assignment has a recommended time period. This is for advice only and can be adjusted depending on the needs of learners.

Supervision: you should be confident of the authenticity of learner's work. This may mean that learners be supervised.

Resources: all learners should have access to the same types of resources to complete the assignment.

Research: learners should be given the opportunity to carry out research outside of the learning context if required for the assignment.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 3: Using Social Media in Business
- Unit 4: Programming
- Unit 9: IT Project Management
- Unit 13: Software Testing
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 20: Business Process Modelling Tools.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop their IT skills and knowledge, including hardware, software and networks. Learners will also be able to enhance their ability to use logic and reasoning.

Unit 12: IT Technical Support and Management

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners investigate the support and management of IT systems, carry out support tasks and prepare a support and management plan, all of which are essential for organisations to operate.

Unit introduction

Effective IT technical support and management of systems are vital to organisation and individual performance. Organisations require their IT systems to perform at their optimum capacity and efficiency, as any downtime of these systems can lead to lost working time or capacity. Individuals working in organisations often lack the technical expertise to maintain their systems correctly and efficiently, which is why support teams are employed to do this job for them.

In this unit, you will examine the support and management needs and characteristics of IT systems used by organisations, identifying areas where support is necessary and the different job roles involved. You will examine the legislation and regulations that are in place to provide a safe and productive environment for employees. You will carry out a series of practical IT support activities on a system and a range of devices, which could include performing software updates and changing user access rights. You will monitor system performance and optimise it to meet the client's requirements. You will learn about and apply appropriate behaviours to complete these activities. Finally, you will prepare a support and management plan for a new IT system.

This unit will help to prepare you for progression to higher education, and in particular it will develop your communication, problem-solving and planning skills, which are valued by higher education providers. It will also prepare you for employment in the IT sector or for an IT apprenticeship.

Learning aims

In this unit you will:

A Examine the IT system support and management needs and characteristics of different organisations, which are essential to their operation

B Carry out routine support and management activities on IT systems

C Develop a plan to support and manage a new IT system using industry standards and methods.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Examine the IT system support and management needs and characteristics of different organisations, which are essential to their operation	**A1** Purpose and nature of IT system support and management **A2** Safe working practices in IT support and management **A3** Job roles in IT technical support and management	A research study of at least two different organisations' IT support and management needs and characteristics. The study should cover four IT support and management characteristics: purpose of the system, safe working practices, job roles, and system and network management tools.
B Carry out routine support and management activities on IT systems	**B1** Management of user support requests **B2** Routine support activities **B3** System management and implementation activities **B4** Performance of IT systems **B5** Personal behaviours	Diary or blog of a range of different completed IT support and management activities and other evidence, including customer service response logs, screenshots and photos. Observation reports, audio or video recording of user, and client feedback.
C Develop a plan to support and manage a new IT system using industry standards and methods	**C1** IT system diagrams **C2** Incident response and disaster recovery planning **C3** Capacity planning **C4** Sustainability and environmental waste planning **C5** An IT technical support and management plan	An IT support and management plan for a new IT system.

Content

Learning aim A: Examine the IT system support and management needs and characteristics of different organisations, which are essential to their operation

A1 Purpose and nature of IT system support and management

The concepts and purpose of IT system support and management.

- The main purpose of IT system support and management is to:
  - support different types of user using the system, including end users who can be classified as beginners, intermediate or expert, and administrators who have access rights that include the support staff
  - provide continuity of IT-based:
    - systems, e.g. servers and virtual personal computers, cloud storage, mobile devices, laptops, bring your own device (BYOD) and network systems
    - processes, e.g. financial management, email communications and stock control
  - maintain and improve the performance of organisations through system diagnosis, preventative maintenance and system upgrade and configuration
  - ensure security and protection of data in the system, including storage and backup and recovery in the event of system failure.
- The support and management needs of organisations varies across the system's life cycle:
  - design, build and test, e.g. install software, configure systems, train and set up users
  - operate, e.g. password resets, fault logging and management, managing data storage
  - decommission, e.g. archive and migrate system data, recycle hardware
  - support resources include: human, number and type of software licences, number and type of hardware devices, capacity requirements, e.g. size of hard disk drive (HDD) and network
  - demand increases due to organisational change, e.g. changes to processes and systems
  - user need for support can be frequent or infrequent depending on their usage of the systems, expertise and access rights
  - support provided is a compromise between cost, the resource availability, productivity of users and the environmental impact, e.g. energy consumption and reuse/recycling of hardware
  - organisational needs can vary by sector, e.g. office, process and engineering industries and entertainment, IT and media sectors.

A2 Safe working practices in IT support and management

The safe working practices for the use and care of IT equipment in organisations.

- Current legal local regulations:
  - effects on the organisation should safe working practices not be followed, e.g. legal action, employee turnover and absence.
- IT support-related health and safety hazards:
  - electrocution and electrostatic discharge (ESD), e.g. from an unprotected power supply
  - fire, e.g. from faulty wiring
  - ergonomics of workstations that could result in injury or reduced productivity.

- Hazard mitigation methods, including ESD wrist strap, ESD mat, firefighting equipment and training, first-aid training.

A3 Job roles in IT technical support and management

The requirements and roles of IT technical support functions.

- First-line support who collect the customer's information and determine the customer's issue by analysing the symptoms.
- Second-line support who prioritise support activities and take on more technical, problem-solving activities.
- Third-line support who understand the strategic priorities, routinely manage the most complex activities and determine underlying problems.
- Infrastructure architects who design enterprise IT solutions.
- Network administrators who often work as part of second- and third-line support.

A4 System and network support and management tools

The functions of the tools that a system administrator and/or manager can use to support the day-to-day running of the system, including:

- network performance monitoring and management tools, e.g. bandwidth and application monitoring and network scanners
- provision of user desktop computing by various means, including server virtualisation with thin client computing and web-based applications
- tools used to create and remotely deploy desktop disk images
- asset management, including software licences
- remote desktop access and control and administration, including performing updates.

Learning aim B: Carry out routine support and management activities on IT systems

B1 Management of user support requests

The concepts of the IT support management processes and systems.

- IT support issues:
  - an issue prevents the intended use or operation of an IT system, or infringes the rule of law or an organisation's policies, e.g. forgotten login details, privacy and copyright, insufficient user training
  - a fault is a defect in either hardware or software that prevents the intended use or operation of an IT system.
- IT support and management processes:
  - issue and fault management, including raising a support ticket, assigning a severity and priority to the request, classifying the request, allocating the request to a support technician, escalation of unresolved requests and communicating the status of requests to users
  - service-level agreements (SLAs) covering request solution and performance monitoring of the IT support function, e.g. ticket volumes, response times, closure rates
  - communicating with user, including listening skills, tone of voice, communicating factual information, e.g. estimated time for repair and estimated cost

  - customer satisfaction and analysis of support request data to identify issues, including training needs, problem software and hardware, scheduling of resources (e.g. time of day/week when most problems occur), staffing issues.
- IT support and management systems:
  - reporting systems, including telephone helpdesk and web-based reporting tools
  - recording information about the issue/fault, including date, name of person, location of issue/fault, type of device, location of device, error code, parts used, description, symptom(s)
  - solution knowledge base and its use to support technicians, e.g. automatic error messages, helpdesk records, questioning the user, technical manuals
  - actions taken, including issue/fault history, record of work carried out.

B2 Routine support activities

The requirements of routine support activities for an IT system, including:

- helpdesk and technical support – issue and fault logging and management, communicating with users, routine support and repair tasks, workaround solutions.
- analysis of system data to identify problem areas and trends and to improve performance, e.g. amount of downtime, application monitoring, system monitoring software
- account management – user account creation, password resets, setting and adjusting access rights, storage area limits.

B3 System management and implementation activities

The requirements of IT system management and implementation activities, including:

- system installation, upgrades and adjusting system settings, including:
  - individual device configuration, e.g. mobile devices, laptops, firewall
  - storage management, including backup and restore
  - upgrades, e.g. random-access memory (RAM), hard drive and additional hardware cards
  - peripheral installation and/or configuration, e.g. printers, scanners or extra monitors
- software management, including patches or new application roll-out, upgrades, e.g. office applications and security, software removal
- disk configuration, including creating network shared drives, creating disk images, setting permissions on folders.

B4 Performance of IT systems

The concepts and optimisation of IT system performance.

- Security optimisation, e.g. firewalls and access control rules, latest patches and known vulnerabilities, device hardening as required, management of system permissions.
- Traffic optimisation, e.g. checking performance, under load, throughput and speed, identifying bottlenecks and how these might be resolved.

- Improving system performance:
  - techniques, e.g. basic input/output system (BIOS) settings, firmware updates ('flashing'), operating systems (OS) settings, memory management, disk optimisation, antivirus, anti-spyware, hardware and software upgrades
  - upgrades, including:
    - hardware processor, e.g. memory, video card, motherboard, router
    - software, e.g. installing patches, installation and un-installation procedures, system rollback.
- Automated system monitoring, e.g. servers, disk space and network availability and monitoring of a system during support activities to ensure it works as intended.

B5 Personal behaviours

The skills, knowledge, and behaviours required when providing IT technical support.

- Time management, including planning, setting relevant targets, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others.
- Behaviours and their impact on outcomes, to include professionalism, etiquette, communication, supportive of others, appropriate leadership, and responsibility.

Learning aim C: Develop a plan to support and manage a new IT system using industry standards and methods

C1 IT system diagrams

The interpretation of computer system documents in written and graphical form.

- Route maps, upgrade paths, schedules, Gantt charts, reports of network performance monitoring and maintenance checklists.

C2 Incident response and disaster recovery planning

The requirements of organisation continuity planning in accordance with the current ISO/IEC 27031 or other relevant international equivalents:

- management of incidents, including identification, classification, and priority of incidents, minimising business impact and workaround solutions
- identifying areas for IT readiness and critical systems
- measure continuity, security and readiness for a potential disaster, including recovery time objective (RTO) and recovery point objective (RPO)
- backup planning
- site mirroring and when this is best implemented
- disaster recovery procedures and planning for unplanned downtimes, including possible workaround solutions.

C3 Capacity planning

Capacity planning processes and considerations for IT technical support and management.

- Capacity of systems based on the type, location and number of concurrent users and overtime and the nature of the work being done.

- Optimisation of networked systems and assets to provide value for money for an organisation.
- Capacity planning to cover the current and future needs of an organisation, based on three-, five- and ten-year intervals.
- Capacity considerations, to include system requirements, scalability, availability and suitability of cloud-based solutions and customer experience.
- Monitoring of the system, e.g. disk, memory and central processing unit (CPU) capacity and performance over the system life cycle and to identify potential bottlenecks, e.g. peaks, spikes and troughs.

C4 Sustainability and environmental waste planning

The requirements of sustainability and environmental waste planning.

- Sustainability considerations, including external service providers/cloud, consideration of finite resources, reduction of waste with recycling, repair of hardware and software instead of replacing, sourcing of products that reduce carbon, remote working.
- Environmental management, including:
  - on-site IT system effects, e.g. ground water, air quality, noise pollution
  - recycling, to include current and relevant parts of the Waste Electrical and Electronic Equipment (WEEE) Regulations 2013 or other international equivalents.

C5 An IT technical support and management plan

The requirements of IT technical support and the management planning process.

- Understand that all IT support and management plans should have a purpose, a defined scope of the IT systems covered, and the client's requirements and constraints.
- An IT support and management plan should cover as a minimum: disaster recovery, incident response, capacity management, and sustainability and environmental management. Other parts of a support and management plan could include:
  - security planning, e.g. apply and monitor procedures for security, including access controls, malware protection, data protection, internet and email protection, encryption, audit trails
  - ergonomics, e.g. workstation layout, positioning of equipment, health and safety issues, including repetitive strain injury (RSI), eye strain, electrical equipment safety, trailing cables
  - floor plans to show the positioning of office furniture, e.g. desks, cabinets and positioning of IT equipment, e.g. workstations, cabling, servers, printers, lighting, air conditioning
  - outsourcing of IT services, e.g. cloud storage, including SLAs
  - other procedures and policies, e.g. fault and issue reporting and escalation process, user support documentation and acceptable usage and safe use policies, e.g. internet.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the IT system support and management needs and of different organisations, which are essential to their operation</td><td rowspan="2">A.D1 Evaluate the support needs and characteristics of different IT systems, justifying where improvements may be possible.</td></tr>
<tr><td>A.P1 Explain the purpose and nature of safe working practices required in the support and management of different IT systems.
A.P2 Explain the job roles and system and network tools used in the support and management of different IT systems.</td><td>A.M1 Compare the support and management needs and characteristics of different IT systems, showing how they would meet the client's requirements.</td></tr>
<tr><td colspan="2">Learning aim B: Carry out routine support and management activities on IT systems</td><td rowspan="2">B.D2 Complete at least six routine IT support activities safely and optimise the system's performance to meet the client's requirements, using processes and behaviours effectively.</td></tr>
<tr><td>B.P3 Complete at least six routine IT support activities safely, using some appropriate processes and behaviours.
B.P4 Monitor the performance of the IT system safely against the client's requirements, using some appropriate processes and behaviours.</td><td>B.M2 Complete at least six routine IT support activities safely and monitor the system's performance to meet the client's requirements, using appropriate processes and behaviours.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a plan to support and manage a new IT system using industry standards and methods</td><td rowspan="2">C.D3 Evaluate, using feedback from others, the refined IT support and management plan, justifying how it fully meets the client's requirements and is fit for purpose.</td></tr>
<tr><td>C.P5 Produce an IT support and management plan that adequately meets most of the client's requirements.
C.P6 Review the IT support and management plan with others to identify and inform improvements.</td><td>C.M3 Justify, using feedback from others, the decisions made for an IT support and management plan, explaining how it will meet the client's requirements and be fit for purpose.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aim: B (B.P3, B.P4, B.M2, B.D2)

Learning aim: C (C.P5, C.P6, C.M3, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- a wide range of research resources, largely text and internet based, including appropriate regulations
- industry standard software, e.g. Packet Tracer, OpenNMS®, Zenoss® Core IP Scanner, Total Network Monitor, operating systems for servers, including open source versions and Mac OS® where possible
- an IT system(s), including as a minimum, Linux®-based and Windows®-based systems and where possible Mac-based.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate the support and management needs and characteristics of at least two different IT systems. The systems will be different in their nature, for example the numbers of users and the IT skill level of the users might be different. The systems may also be different in the way support is provided, for example in-house or outsourced. Learners' evaluation will include a comparison of the support and management provided and will give clear, reasoned justification of where improvements might be possible. For example, a support team managing a system with a large number of non-expert IT users might develop online training materials to update users' skills with the latest version of office software.

Learners will produce a clear and balanced evaluation that will be logically structured and easy to understand by a third party who may not be an IT professional. Technical language must be fluent and accurate throughout, along with a good standard of grammar and spelling.

For Merit standard, learners will compare the support and management needs and characteristics, including the purpose and nature, safe working practice, job roles and tools used, to support and manage at least two different IT systems. For example, in an office-based environment such as telesales, there is typically significant in-house IT support as many users will not be IT experts and the systems are business critical, whereas in a software development company, IT support is likely to be minimal as most users are likely to be experts.

Overall, the comparison will be clear and logically structured, technically accurate and easy to understand.

For Pass standard, learners will explain the purpose and nature of the safe working practices required to support and manage different IT systems. For example, in an office environment, the display screen equipment (DSE) regulations are important to prevent injury or discomfort.

Learners will explain the common job roles and system and network tools used to support and manage at least two different IT systems. For example, in an office-based environment with a large number of users, support roles are likely to include 1st, 2nd and 3rd line support and an infrastructure architect. However, in a software development company, 1st line support may not be required as most issues raised will be complex technical ones.

Overall, the evidence will be logically structured. It may be basic in parts, for example covering more generic statements that do not link to the context. The evidence may contain minor inaccuracies or omissions for example, the name of a regulation may be incorrect.

Learning aim B

For Distinction standard, learners will complete at least six routine support activities effectively and safely to meet the client's requirements. They will carry out performance monitoring of the system and will optimise the system to meet the client's requirements, based on their findings.
For example, by adjusting security settings, updating software, adjusting the operating system configuration and carrying out hardware upgrades. They will provide detailed evidence of the optimisation they have done and how it is intended to improve performance.

Overall, learners' evidence will demonstrate that they have understood how systems can be optimised during support and that they can demonstrate effective behaviours while completing the activities. For example, effective behaviours may include time management, where learners will prepare an activity plan before starting the assignment and/or how they collected feedback on their users' satisfaction. Learners will use technical language fluently and accurately, showing a clear understanding of IT support and management.

For Merit standard, learners will demonstrate in their evidence that they can complete at least six different routine IT support activities safely and will use appropriate processes consistently. For example, learners will record each issue or fault correctly and assign a corresponding severity and priority. Learners will use appropriate processes while monitoring the performance of the systems. For example, when taking user feedback and using network specific monitoring tools, such as a Packet Tracer.

Overall, learners' evidence will demonstrate that they can complete different technical support activities to meet the client's needs. The evidence will also demonstrate that appropriate behaviours have been used, for example taking responsibility and being professional.

For Pass standard, learners will demonstrate in their evidence that they are able to complete at least six different support activities safely. For example, they might configure devices, complete a backup and restore, upgrade some hardware, install a peripheral device, create a shared drive and install an application. During the activities, learners will demonstrate the application of some appropriate processes. For example, learners will configure a laptop using the correct process but they may not take sufficient and accurate notes of the issue and its resolution.

Learners' evidence will demonstrate that they can monitor a system's performance against the client's requirements. For example, learners might monitor the application performance on a network and identify a shortage of bandwidth.

Overall, the support activities should be fully completed and there will be evidence of using some appropriate behaviours. For example, learners may listen closely to a user's issue or fault but their tone of voice may not be appropriate.

Learning aim C

For Distinction standard, learners will evaluate their refined IT support and management plan and will consider the feedback from others. They will provide evidence of the feedback they have obtained and show how they have used it. For example, those parts of the plan that are fully complete and those that may need further information to fully meet the client's requirements.

Overall, learners' evidence will be logically structured and easy to understand by a third party who may not be an IT professional. Accurate technical language must be used fluently, along with a good standard of grammar and spelling. If any diagrams are present then they will be appropriately detailed, fully annotated and technically accurate.

For Merit standard, learners will provide in their evidence a clear, balanced and sound justification to support decisions taken in their IT support and management plan. For example, learners may justify the choice of operating system by giving an accurate and reasoned rationale for their choice. The justification given will mirror the client's requirements and be fit for purpose.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will produce an IT support and management plan for a given system that may include diagrams. As a minimum, the plan will cover incident response, disaster recovery, capacity planning, sustainability and environmental waste planning, and at least one other aspect of IT support and management. Learners' evidence will clearly show how the plans adequately meet most of the client's requirements.

Learners will review their IT support and management plan with others and use the feedback to make improvements to the plan. For example, their original plan may lack detail about how the system is to be protected from external hackers and amend their plan by adding details about how a firewall can be installed and configured.

Overall, the evidence will be logically structured. It may be generic in parts and/or contain minor inaccuracies or omissions. For example, learners' plan may not fully meet the client's requirements as it may explain how faults will be reported but it does not fully explain how they will be escalated if they remain unresolved.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 9: IT Project Management
- Unit 11: Cyber Security and Incident Management
- Unit 14: Customising and Integrating Applications
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 18: The Internet of Things.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used in IT technical support and management
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 13: Software Testing

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore a range of testing methodologies used in commercial software development projects and carry out appropriate tests on a piece of code.

Unit introduction

Ensuring the quality of software programs is an essential part of any software development project and testing is the process used to quality assure software. Software can be categorised into products that are deliverable computer programs, such as an application or website, and services that are background applications, which communicate with a database or a third party, for example an application programming interface. Products are typically tested with automated tools, and scripts and services are typically tested with a functional testing tool, such as SoapUI or unit tests written by software developers.

In this unit, you will learn about the different software testing methodologies that are used as part of commercial software development projects, and the effects of different software development methodologies. You will analyse the user requirements for a software product or service to produce suitable test plans, based on specifications and development tasks, and select and apply different test methodologies to the software post development. You will evaluate and present the results of your testing to inform development team members of their progress and success.

Ideally, this unit should be delivered alongside, or after, *Unit 4: Programming* and *Unit 9: IT Project Management*.

The analytical and problem-solving skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment, for example as a junior software tester.

Learning aims

In this unit you will:

A Understand the software development and testing methodologies commonly used during the development life cycle to quality assure software

B Carry out a range of testing methodologies on a software product to meet a client's needs

C Review and present the results from software tests to meet a client's needs and suggest improvements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Understand the software development and testing methodologies commonly used during the development life cycle to quality assure software	**A1** User requirements and typical software project job roles **A2** Characteristics of common software testing methodologies **A3** Features of testing for different software development methodologies	A report into the characteristics of different testing methodologies used in two different software development projects and how the choice of project methodology affects the testing method, software product, user requirements and team members.
B Carry out a range of testing methodologies on a software product to meet a client's needs	**B1** Common tools and processes used in software testing **B2** Selecting appropriate test methodologies **B3** Test plan **B4** Product testing	A portfolio of evidence from testing a software product. The evidence should include an overview of testing tools used, why the methodology was chosen, test plans and the results of product testing.
C Review and present the results from software tests to meet a client's needs and suggest improvements	**C1** Test evaluation and presentation of results **C2** Test plan improvements	A written summative report on the testing carried out and the results of the testing. Statistical analysis on time taken to test bugs and pass/fail/skip rates. Additions to test plan, to include newly found bugs that were not initially considered in the preparation stage.

Content

Learning aim A: Understand the software development and testing methodologies commonly used during the development life cycle to quality assure software

A1 User requirements and typical software project job roles

The user requirements and typical project job roles in software development projects.

- User requirements, e.g. functions the software needs to perform, problems with a current system or a process that needs to be improved.
- Typical job roles in a software development team, including:
  - software developers – design and build computer programs to solve problems
  - testers – ensure functionality and uncover potential problem areas for the user
  - business analysts – provide a communication point of contact between the development team and project manager
  - project managers – ensure the smooth and effective running of a project's development and its resources (people, finances and infrastructure)
  - product owners – stakeholders in a project, take responsibility for a project and promote it throughout the organisation.

A2 Characteristics of common software testing methodologies

The different types, applications and output of different software testing methodologies.

- Unit testing, including developer-led, 'friendly' classes, written and performed during development by a development team member before deploying the software.
- Acceptance testing, including build verification, 'smoke testing', written based on the client brief and tested by the customer before 'sign off'.
- Functional testing, including user stories, functionality in a feature, error handling, testing of the software according to user cases provided by the specification.
- System testing, including end-to-end testing, series of features ensuring functionality and processes, according to the functional specification, where no knowledge of code design is required, testing to ensure the product meets client expectations.
- Performance testing, including mean time to failure, resource usage, system requirements, load testing the software post-development to ensure performance during busy periods and high traffic or use.
- Security testing, including static (examining and reviewing) and dynamic (running code) testing, penetration testing, testing during the post-development stage to identify security flaws, possible data protection and account protection issues.
- Regression testing, including continuous testing of a solution to ensure existing functionality still works as expected, as new features are added. Carried out on a static build of the software, where a full software test can be performed to ensure no new issues occur within the product.
- Stress testing, including deliberately intense testing to break and determine the stability of a system, tests the efficiency of a product under heavy load and use.

- Usability testing, including direct input on how users use the system, key testing technique in user-centric design, testing can use eye trackers or similar techniques to identify bottlenecks in software usability from the perspective of the user.

A3 Features of testing for different software development methodologies

The testing, approaches and features of different software development methodologies.

- Approach and features of testing in an Agile (scrum) development methodology, including:
  - software requirements specification, e.g. outlining functional and non-functional requirements translated from business needs, user interface mock-ups
  - test scripts and test cases developed from the created user stories to define and test user functionality in the software
  - advantages and disadvantages of testing using the Agile methodology
    - advantages include flexibility of the project for change, encouragement of stakeholders in a project, constant team involvement and communication, and improvement is continuous as lessons are learned through reviews
    - disadvantages include planning of the delivery date is estimated based on the complexity of work, team members must be experienced, more time is required for planning
  - Agile methodology is often used when there is scope for change from the client, and the product evolves through its development and deployment life cycle.
- Approach and features of testing in a waterfall development methodology, including:
  - testing as a final phase only after the development of the product is complete, the effect of development work has little impact on testing
  - advantages and disadvantages of testing using the waterfall methodology
    - advantages include easy forwards and backwards planning, visible output at the end of the process, provides a base product to move forward with future development
    - disadvantages include lack of flexibility to cater for change due to impacts in time, resource and budget, potential to derail the entire project should undefined risks and constraints arise
  - waterfall methodology is often used when the client's requirements are well defined, the technology is understood and for a new version of an existing product.
- Approach and features of testing in a kanban development methodology, including:
  - testing after the development of the feature is complete, testing takes place in a post-development and pre-production phase
  - work is completed 'just-in-time' so testing must follow that, testing is carried out per work item, rather than on a whole project. Regression testing should be performed on the complete product before delivery
  - advantages and disadvantages of testing using the kanban methodology
    - advantages include the continuous delivery during the development phase. Changes in scope are flexible and as needed like Agile, but also not as strict as waterfall
    - disadvantages include lack of work causes downtime for the development team, not suited to research and development projects where work is not imminent, not suited to projects that require detailed planning
    - kanban is often used where issues and features are required in products already in the deployment or maintenance phase, where a new implementation is not essential but add-ons or patches are required as part of a continuous just-in-time process.

Learning aim B: Carry out a range of testing methodologies on a software product to meet a client's needs

B1 Common tools and processes used in software testing

The concepts and processes of test tools to meet a client's needs.

- Applying testing tools and when they are used, including:
  - methods of recording information, e.g. cloud solutions, text-based, automation tools, investigating the advantages and disadvantages of each type such as ease of use, audit trails and reporting functionality
  - build servers, where automation and unit tests can be automatically deployed on developer source control check-ins
  - external testing companies, outlining the advantages and disadvantages of outsourcing such as the effective cost of testing externally, the lower overheads in an expensive development team, against the effect on morale within the business of outsourcing local and national jobs, and protection of intellectual property.
- Testing processes, including:
  - quality assurance processes for software bugs, including description, steps to reproduce, affected version, fix version, actual result, expected results and importance (minor, major, critical) for each 'bug'
  - change request, e.g. processes, policies, bug reviews
  - debugging is the process of finding and fixing bugs in code.

B2 Selecting appropriate test methodologies

The uses and requirements of test methodologies.

- Service testing, to include testing Simple Object Access Protocol (SOAP) and Representational State Transfer (REST) services, their load and performance across their servers, including security testing.
- Application testing, e.g. functionality, system, performance.
- Automation testing, e.g. tools, setup and scripting.
- Regression testing, e.g. create test suites, test the product against the suite, identify faults and causes of faults, build up the test suite with any new faults found, repeat until there are no new issues and existing issues pass.

B3 Test plan

- Test plan contains a range of appropriate test methodologies and test scripts.
- Test scripts, to include the following information: title, description of test case, steps to reproduce, expected results, actual results, importance of test.

B4 Product testing

The application of acceptance and regression testing processes.

- Acceptance testing, including:
  - user requirement identifier – usually a reference to a requirement number from the specification, or an identification (ID) of a story used in development
  - result of test with comment on why test failed or passed.
- Regression testing, including:
  - grouped test cases on product areas, screens, functionality, features
  - test run plans and results
  - raising of bugs
  - overview of passed, failed and skipped tests.

Learning aim C: Review and present the results from software tests to meet a client's needs and suggest improvements

C1 Test evaluation and presentation of results

The requirements, recording and presentation of the test evaluation.

- Summary of test results, to include a comparison of passed, failed and skipped tests.
- Raising of undocumented bugs.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Presentation communication skills, including:
  - the ability to convey intended meaning, e.g. written and verbal
  - graphical and numerical data, e.g. pie charts showing passed/failed/skipped summaries and line graphs showing numbers of raised bugs against fixed/ resolved issues
  - recording documentation, reports, visual aids for presentation use
  - verbal communication requirements, including one-to-one and group informal and formal situations
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on an audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, and avoidance of jargon
  - responding constructively to the contributions of others, e.g. being supportive, managing.

C2 Test plan improvements

The requirements of the testing outcome and feedback to others.

- New test cases based on found, undocumented bugs.
- Preparation for regression based on developer work.
- Feedback to development team on results of testing, ensuring failed and skipped tests are accurate to the user specification and development team understanding.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Understand the software development and testing methodologies commonly used during the development life cycle to quality assure software</td><td rowspan="2">A.D1 Evaluate the characteristics of testing methodologies used in software development projects and how the choice of project methodology affects the testing method, software product, requirements and team members.</td></tr>
<tr><td>A.P1 Explain the characteristics of testing methodologies used in software development projects and how the choice of project methodology affects the testing method, software product, requirements and team members.</td><td>A.M1 Compare the characteristics of testing methodologies used in software development projects and how the choice of project methodology affects the testing method, software product, requirements and team members.</td></tr>
<tr><td colspan="2">Learning aim B: Carry out a range of testing methodologies on a software product to meet a client's needs</td><td rowspan="2">B.D2 Perform a comprehensive and appropriate range of tests systematically and meticulously on a software product against the user requirements, using an effective test plan.</td></tr>
<tr><td>B.P2 Select test methodologies for a software product.
B.P3 Produce test cases for a software product to be tested.
B.P4 Perform tests on a software product against the user requirements, using the test plan.</td><td>B.M2 Perform tests systematically on a software product against the user requirements, using an effective test plan.</td></tr>
<tr><td colspan="2">Learning aim C: Review and present the results from software tests to meet a client's needs and suggest improvements</td><td rowspan="2">C.D3 Present a cohesive and clear evaluation of the results of testing using graphical and written methods, comparing the passed, failed and skipped tests and suggest reasoned improvements to the test plan.</td></tr>
<tr><td>C.P5 Explain the results of testing using graphical and written methods, suggesting basic improvements to the test plan.
C.P6 Present generally clear results from testing to a development team member.</td><td>C.M3 Analyse the results of testing using graphical and written methods, comparing the passed, failed and skipped tests and suggest reasoned improvements to the test plan.
C.M4 Present clear results from testing to a development team member.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aim: B (B.P2, B.P3, B.P4, B.M2, B.D2)

Learning aim: C (C.P5, C.P6, C.M3, C.M4, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- a developed software program with a clear specification
- an integrated development environment, e.g. a visual studio to perform unit tests and, if required, automated tests
- testing software, e.g.:
  - web services e.g. SoapUI or a free alternative
  - test management software, e.g. Tarantula (free) and TestLodge and HipTest (commercial and paid for alternatives).

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate the characteristics of different testing methodologies used in two different software development projects, and the effect that the development methodology has on these projects. They will give advantages and disadvantages of each methodology, justifying its suitability for each project. Learners will suggest alternative solutions should the methodology not be suitable, with reasoning. For example, in the development and testing of a large software project with undecided requirements, learners will evaluate the waterfall and Agile methodologies and decide that even though waterfall is a solid and proven model, it is not appropriate for the iterative releases that such a project requires. They may suggest that an Agile approach would be beneficial to the project due to its flexibility and opportunities to release software builds. Learners may also suggest that a disadvantage of Agile is the steep learning curve required by developers and stakeholders in the project methodology, which results in resource and training costs.

Overall, the evidence, such as a case study or specification, will be easy to read and understand by a third party who may be an apprentice software tester. It will be logically structured and use technical engineering and software development terms with a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will compare the characteristics of different testing methodologies used in two different software development projects. They will also compare the effect that using two different project development methodologies has. For example, an advantage of using the Agile project methodology is that the scope of the software product and the test scripts can be easily changed to meet the customer's requirements compared with the waterfall methodology, where the client's needs and test scripts are fixed early on in the project life cycle.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will explain the characteristics (types, applications and output) of different testing methodologies used during two different software development projects. They will also explain the effect that the choice of development methodology has on the software product, testing methodologies, user requirements and team members. For example, a large software development project may use an Agile methodology, as the requirements of the project can be changed based on user requirements, which means that the test scripts can also be adapted. Also, performance testing is likely to be important to determine the reliability of the product in a safety critical application.

Overall, the evidence will be logically structured and it may be basic in parts. It may also contain minor technical inaccuracies relating to software testing terminology.

Learning aim B

Please note that if this unit is to be delivered alongside another BTEC programming unit, then the best delivery approach is to use the Agile software development methodology for learning aims B and C. If this unit is to be delivered after another BTEC programming unit, then the best delivery approach is to use the waterfall software development methodology. The alternative is to provide a software program and documentation to be tested.

For Distinction standard, learners will perform a comprehensive and appropriate range of self-planned and created tests systematically and meticulously against a software product, showing appropriate detail and accuracy. For example, an appropriate range of tests will focus on the vast majority of aspects, from using a software product and performing simple tasks, to fully detailed processes in the software product, finding potential faults and predicting errors. Learners will develop an effective test plan based on user requirements (initial specification of the product), and the continuous testing of the product and accurate recording of the test results will be used to build up a bank of issues, such as user errors or system faults (meticulously).

Overall, the evidence, such as a portfolio, will be easy to read and understand by a third party who may be an apprentice software tester. It will be logically structured, using technical engineering and software development terms and consistent reference of information sources.

For Merit standard, learners will perform tests systematically on the software product against the user requirements using their test plan (containing the test methodologies and test cases). For example, they will follow the testing processes systematically by carefully following an effective test plan that contains detailed steps to reproduce the feature while considering the expected results for each test, the importance of the test and recording the test results. Some of the tests selected by learners may not be appropriate for the context.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will select the test methodologies to use on a software product. For example, they will choose to unit test the core functionality of a software product.

Learners will produce test cases based on a software specification or user requirements for each product. For example, a test case for logging into a software product will consist of a title ('Main Program: The user can log into the system'), with steps to reproduce (1: Open the program, 2: Type username into username text box, 3: Type password into password text box, 4: Press or click login button). Expected results would contain, 'The user will log in to the system', and actual results would be left blank until the test is carried out.

Learners will perform tests on the products using a test plan, which contains the range of tests to be conducted and the test cases, formed from the analysis of the user requirements document. For example, the requirement may state that they have the ability to manage their own user accounts in the software. A range of tests would need to be written to cover the 'manage' term for this requirement, such as adding, removing and editing users.

Overall, the evidence will be logically structured and it may be basic in parts. It may also contain minor technical inaccuracies relating to software testing terminology and some of the tests selected may not be appropriate or performed systematically.

Learning aim C

For Distinction standard, learners will present a cohesive and clear evaluation of the results of testing using graphical and written methods. They will compare the passed, failed and skipped tests (giving reasons why they were skipped), and suggest reasoned improvements to the test plan. Learners do not have to rectify the failed or skipped tests and will focus on the process of testing, and how it can be improved during the next round of software testing. Learners will consider testing as a continuous improvement process, in order to improve the software product and quality assurance process. For example, the evaluation will describe the process carried out through testing by providing a justification about why a test failed, and if any tests were skipped, valid reasons will be given about why they could not test that functionality and why they were not marked down as failed. If a test fails to include a key step that helps the test to pass or causes it to fail, then it will be included in the test case as an improvement.

Overall, the evidence, such as a report, will be easy to read and understand by a third party who may be an apprentice software tester. It will be logically structured and use technical software testing terms and consistent reference of information sources.

For Merit standard, learners will analyse the result of software testing using graphical and written methods. Their analysis will compare the passed, failed and skipped tests and suggest improvements to the process and test plan. For example, a test case may exclude detail in the key steps, causing a test to fail, such as recording the specific test 'username' and 'password' used in the test. Learners will present clear results from testing to a development team member who can then move failed and skipped tests towards the pass goal. For example, the tests are comprehensive and do not contain missed steps.

Overall, the evidence, including the presentation, will be logically structured, technically accurate and easy to understand by a development team member.

For Pass standard, learners will explain the results of testing using graphical and written methods. For example, they will present a report of grouped passed, failed and skipped tests with a pie chart of the results.

Learners will suggest basic improvements to the test plan that will improve their quality assurance process for future test iterations. For example, the steps to reproduce the issue may contain similar information to the title of the bug. Also, adding clear steps to reproduce the issue would be a basic improvement.

Overall, the evidence will be logically structured and it may contain minor technical inaccuracies relating to software testing terminology. The presentation may be basic in parts and the results should be generally clear. For example, a presentation may contain tests that have missed steps and cause them to fail when the functionality is present.

Links to other units

This unit links to:

- Unit 4: Programming
- Unit 6: Website Development
- Unit 7: Mobile Apps Development
- Unit 8: Computer Games Development
- Unit 14: Customising and Integrating Applications
- Unit 18: The Internet of Things.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used in the software testing process
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 14: Customising and Integrating Applications

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore and develop customised and integrated applications to meet organisational needs, such as to offer greater flexibility and improve performance.

Unit introduction

Application software often requires extra functionality to support organisational processes and to improve the performance and/or flexibility of an organisation. Customised and integrated applications may provide a cost-effective way for an organisation to create solutions rather than developing software from scratch or purchasing bespoke software. For example, integrating apps with social media, providing automation using Google Docs™ and SharePoint® integration with cloud technology.

In this unit, you will explore how different technologies, such as Visual Basic® for Applications (VBA), AppleScript®, application programming interface (APIs) and third-party extensions can be used to extend the functionality of applications, including cloud products such as Software as a Service (SaaS). These technologies allow businesses to customise and integrate applications with greater scope and flexibility than is possible using off-the-shelf software. You will explore different technologies and techniques for customising and/or integrating applications by undertaking a series of short activities, analysing the results. You will design, implement and test a customised and integrated software application to solve a problem requiring the use of a range of applications, such as office software or cloud solutions.

Ideally, this unit should be delivered after, or perhaps alongside, *Unit 4: Programming*.

The knowledge, understanding and skills, such as problem solving, you gain in this unit support progression to higher education courses. The unit will help you when entering an IT apprenticeship or the workplace.

Learning aims

In this unit you will:

A Investigate the customisation and integration of applications used by organisations to meet their needs

B Explore the technologies and techniques used to customise and integrate applications

C Develop customised and integrated applications to meet organisational needs.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the customisation and integration of applications used by organisations to meet their needs	**A1** Types of application software **A2** Purpose of and issues with customising and integrating applications **A3** Software customisation and integration	A detailed presentation or report evaluating the customisation and integration of applications.
B Explore the technologies and techniques used to customise and integrate applications	**B1** Integrated development environments (IDEs) **B2** Programming constructs and techniques for customising and integrating applications **B3** Testing customised and integrated applications	A practical activity to develop short prototype software solutions that demonstrates the integration and customisation of different software applications. A report focusing on what went well and what did not go so well when customising and integrating software applications using different technologies.
C Develop customised and integrated applications to meet organisational needs	**C1** Design for customised and integrated applications **C2** Develop customised and integrated applications **C3** Testing customised and integrated applications	A practical activity involving defining the specification for the problem, designing and developing fully working customised and integrated software applications to meet a client's needs.

Content

Learning aim A: Investigate the customisation and integration of applications used by organisations to meet their needs

A1 Types of application software

Investigate the use of application software that can be customised and integrated:

- office, e.g. word-processing software, spreadsheet software, database software, presentation software
- internet, e.g. web browser software, email software
- security, e.g. antivirus software, firewall software
- cloud software, e.g. Google Docs™, Dropbox™, Microsoft OneDrive®, Google Drive™, iCloud®, Adobe Document Cloud®.

A2 Purpose of and issues with customising and integrating applications

The concepts and requirements of customising and integrating applications.

- Differences between the approach of customising applications and integrating them:
  - customising applications involves modifying the user interface, e.g. grouping frequently used tools and simplifying the interface and/or adding additional capabilities, e.g. automating repetitive tasks and creating new analytical procedures
  - integrating applications involves sharing of processes and data among different applications, e.g. presentation, database(s), and communication software and devices, e.g. smartphones, wearable devices, tablets.
- Purpose of customising and integrating applications is to facilitate data sharing between applications and devices, automate complex tasks, extend functionality of the software, add finesse to a solution, and to improve the performance, usability and efficiency of a solution.
- Common issues with data customisation and integration, including:
  - misinterpretation of requirements, e.g. verification and validation, data integrity, lack of user involvement, user-friendliness
  - consistency and composition, e.g. validation, error checking the format
  - communication protocols, e.g. Transmission Control Protocol/Internet Protocol (TCP/IP), Network Time Protocol (NTP), acknowledgement, message delivery
  - data sharing and service delivery capabilities, e.g. security, access violation
  - data security and cloud technology, e.g. data breaches, hacked interfaces and APIs, permanent data loss, denial-of-service (DOS) attacks and shared technology.
- Solutions to these issues, e.g. for data security and cloud technology data compartmentalisation, and SaaS.

A3 Software customisation and integration

The requirements of the software customisation and integration process.

- Common programming languages used to customise and integrate applications include: VBA, AppleScript, PHP, Python™, Java™, .NET, Structured Query Language (SQL).

- Common factors to consider when choosing a suitable programming language to customise or integrate an application, including ease of learning, speed of development, platform environment, portability, fitness for purpose, code performance, data security and cloud technology.
- Software customising, including:
  - spreadsheet software, e.g. automated routines and using buttons
  - email software, e.g. feedback, acknowledgment
  - database software, e.g. menu/interface
  - web software, e.g. interface, automatic availability, live data.
- Application software integration, including:
  - enterprise resource planning (ERP) and customer relationship management (CRM) software using automated .csv or txt file imports
  - electronic data interchange (EDI)
  - bespoke application
  - cloud-based software, e.g. Microsoft Exchange® or SharePoint, Google Cloud™ connect, Samepage
  - web service with applications or systems.

Learning aim B: Explore the technologies and techniques used to customise and integrate applications

B1 Integrated development environments (IDEs)

The requirements for IDE functions for different technologies, including:

- source code editor, build tools and debugger, properties of forms, positioning of objects, fields and labels, API, object classes, routines, data structure, Simple Object Access Protocol (SOAP).

B2 Programming constructs and techniques for customising and integrating applications

The requirements of a range of constructs and techniques to customise and integrate applications, including:

- techniques, including routines and functions, parameter passing, selection processes, variables and arrays
- programming structures, including iteration, while and until loops, selection, subroutines, parameter passing, functions, case, nested structures
- programming application software, including handling objects and controls, properties of forms, positioning of objects
- handling database and/or spreadsheet objects and controls
- manipulating a worksheet or cell
- accessing tables
- modifying forms
- modifying reports and/or charts and graphs
- validating and/or verifying data
- searching tables and/or worksheets and external files sequentially to locate and amend specific information.

B3 Testing customised and integrated applications

The application of formative and summative testing to test process.

- Be able to test customised and integrated applications, including:
  - unit testing, where parts of the program are treated as black box to determine if an expected output is achieved from a known input
  - program simulation and/or onscreen monitoring
  - dry run the program
  - testing against user requirements, e.g. verification and validation.
- Debugging, including syntax errors, logical errors and error correction.

Learning aim C: Develop customised and integrated applications to meet organisational needs

C1 Design for customised and integrated applications

The concepts and processes of the design of integrated applications.

- User requirements, including:
  - problem definition:
    - context
    - customised and integrated solution requirements
  - success criteria measures
  - user interface requirements
  - constraints.
- Design of customised and integrated applications, including:
  - design ideas and/or prototypes for customised and integrated applications
    - diagrammatic illustrations, e.g. screen layouts, user interfaces, navigation
    - processing stages, e.g. flow charts, events
    - control structures
    - Unified Modelling Language (UML), e.g. activity diagrams
  - test plan with test data.
- Reviewing and refining customised and integrated applications, including:
  - communicating with clients, e.g. email, verbal communication
  - gathering feedback from others to help refine alternative design ideas and/or prototypes and to help make decisions
  - refining ideas and solutions
  - updating design specification documentation, based on review and feedback
  - evaluating the effectiveness of the approach and technique used.

C2 Develop customised and integrated applications

The concepts, processes and review of integrated applications development.

- Customise and integrate applications to meet the organisational requirements.
- Effective use of programming language constructs and techniques.
- Effective use of programming application software.
- Use of diagrammatic illustrations.
- Use of control structures.

- Review and refine a customised and integrated application solution, including:
  - refining the customised and integrated solutions to take account of issues discovered during testing
  - refining the customised and integrated solutions to take account of the feedback and client requirements
  - factors that could be used to extend the functionality of the customised and integrated solutions, e.g. making the interface more user-friendly and online help to support training needs.

C3 Testing customised and integrated applications

The application of formative and summative functionality testing, including feedback from others.

- Undertake functional testing of the applications against the test plan.
- Undertake testing to establish:
  - whether the customised and integrated solutions meet all of the requirements
  - whether the customised and integrated solutions function as expected
  - user feedback on the quality, including reliability, usability, performance of the solutions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate the customisation and integration of applications used by organisations to meet their needs</td><td rowspan="3">A.D1 Evaluate why and how customised and integrated applications meet organisational needs and what the difference and common issues are with each approach.</td></tr>
<tr><td>A.P1 Explain why common applications are customised and integrated to meet organisational needs and what the difference and common issues are with each approach.
A.P2 Explain how common applications are customised and integrated to meet organisational needs.</td><td>A.M1 Compare why and how customised and integrated applications meet organisational needs and what the difference and common issues are with each approach.</td></tr>
<tr><td colspan="2">Learning aim B: Explore the technologies and techniques used to customise and integrate applications</td></tr>
<tr><td>B.P3 Explain, using short example solutions, how applications are customised and integrated to better meet organisational needs.</td><td>B.M2 Assess accurately, using short example solutions, how applications are customised and integrated to better meet organisational needs.</td><td>B.D2 Critically analyse, using short example solutions, how applications are customised and integrated to better meet organisational needs.</td></tr>
</table>

Pass	Merit	Distinction
Learning aim C: Develop customised and integrated applications to meet organisational needs		
C.P4 Produce designs with some inconsistencies for customised and integrated applications to meet organisational needs. **C.P5** Review the design with others to identify and inform improvements to the proposed application's design. **C.P6** Produce customised and integrated applications to meet organisational needs. **C.P7** Test the customised and integrated applications for functionality and for acceptance against the organisational needs.	**C.M3** Justify design decisions made, showing how the customised and integrated applications will result in an effective solution. **C.M4** Optimise the customised and integrated applications to meet organisational needs.	**C.D3** Evaluate the designs and the optimised, customised and integrated applications against organisational needs.

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aim: B (B.P3, B.M2, B.D2)

Learning aim: C (C.P4, C.P5, C.P6, C.P7, C.M3, C.M4, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use the tools and techniques to customise and integrate applications, for example:

- spreadsheet, database, web development and email software
- web service, e.g. SoapUI® or free alternative
- mobile devices to support testing, e.g. wearable devices, tablet devices, smartphones
- programming application software, e.g. visual studio, Java, Python.

The solutions can be created using live hosted resources (self-hosted or using third-party servers) or simulated using virtual machine(s).

There is a range of commercial and open source resources available, some of which are free and others are paid for. This unit does not recommend any particular technology.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate why and how customised and integrated applications meet organisational needs. They will draw on varied information, themes and/or concepts, including a comparison of the customised and integrated applications with off-the-shelf applications and the factors that need to be considered in deciding which technology to use. Learners' evaluation will lead to a supported judgement, showing relationship to its context. For example, one factor that may be considered for using the cloud for shared technology is data security because it is vulnerable to data loss and insecure interfaces. One way to reduce the security threat is data encryption.

Overall, the evidence will demonstrate high-quality communication through the use of accurate and fluent vocabulary, supporting a logically structured and thought-out response that clearly connects reasoning.

For Merit standard, learners will compare why and how customised and integrated applications meet organisational need and will include a comparison with off-the-shelf applications. For example, off-the-shelf office applications offer limited functionality in comparison to customised and integrated applications that are modified to provide improved functionality, such as to transfer data between spreadsheets and a database. The evidence will show how the software applications meet the organisational needs and what the difference and common issues are with each approach.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will explain why common applications are customised and integrated using the different types of application software. They will understand the difference between customisation and integration and they will explain the issues related to customised and integrated applications. For example, a spreadsheet may be customised to improve productivity through the automation of repetitive tasks by using a macro.

Learners will explain how common applications are customised and integrated to meet organisational needs. For example, a spreadsheet may be customised by adding a data entry form so that data can be shared and integrated in a database used by other parts of the organisation.

Overall, the evidence will be logically structured but may be basic in parts. For example, learners may state that error checking and validation are important issues to consider when customising a spreadsheet, but may not link their statement back to the context to explain why it is important (to ensure that data is valid and reliable) and that some data may not need to be checked and validated if it is not important. The evidence may contain minor technical inaccuracies or omissions.

Learning aim B

The assignment should develop learners' knowledge and understanding of customising and integrating applications through a series of at least six short software-related activities.

For Distinction standard, learners will critically analyse how applications are customised and integrated by using short example solutions. They will present the outcome of methodical and detailed examination of the solutions. They will include consideration of alternative ways of completing the activities and provide recommendations for their preferred approach. For example, to create the user interface for a given database, learners may consider the security implications of different approaches. The preferred approach might be to hide the password as it is entered and to check the content and length of the password as it offers better protection of sensitive data than a less secure approach to only check the content of the password.

Overall, the evidence will demonstrate high-quality communication through the use of accurate and fluent vocabulary, supporting a logically structured and thought-out response that clearly connects reasoning.

For Merit standard, learners will present a careful and accurate assessment of how short activities to customise and integrate applications were undertaken. For example, to create the login user interface for a given database, learners' evidence may include a design sketch of the layout, a flow chart for the password routine, a screenshot of the programming routine and the test results.

Overall, the evidence will be a well-organised record of the practical work carried out. It will be technically accurate and easy to understand.

For Pass standard, learners will explain, by using short example solutions, how to customise at least three applications and how to integrate at least three applications to better meet an organisational need. For example, learners may explain how to customise the user interface for a given database that automates actions to login, append, update, delete and/or find records.

Overall, the evidence will be a logically structured record of the practical work carried out. It will be easy to follow but the descriptions may be basic and the use of technical language may be inconsistent. For example, when explaining what tests were completed for a login routine, learners may only check for valid entry and not invalid and extreme entries.

Learning aim C

The assignment should draw on the skills, knowledge and understanding gained in the rest of the unit and it should involve the customisation and integration of software applications to meet an organisational need.

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the design decisions, technologies and techniques applied throughout the development of an optimised solution impacted on the effectiveness against the organisational needs. Learners will make suitable and reasoned justifications of the decisions taken in comparison to alternative solutions. For example, they may justify the use of database software, explaining the limitations between alternatives such as Oracle® and Access®. This could include compatibility of technology such as Python, PHP which is not supported by Access.

Overall, the evidence will demonstrate that learners can evaluate the designs and the optimised applications to meet organisational requirements and that they can work professionally and independently. Technical terminology will be correctly and consistently used. The evidence will be easy to read and understand by a third party.

For Merit standard, learners will design an effective solution to meet the organisational needs by customising and integrating applications. The design will be effective as it will provide sufficient detail for the applications to be developed and appropriate justification will be provided on design decisions for alternative solutions. For example, an online booking system may include a text box and command button to search records instead of a drop-down combo box because learners will demonstrate through testing that it is functional and a more user-friendly approach. During the development process, and using feedback from testing, they will optimise their applications. For example, for an online booking system, an improvement could be to allow users to search for particular dates and available bookings.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will produce a design with some inconsistencies for applications that require both customisation and integration to meet an organisational need. For example, design inconsistencies for an online booking system could be that the user interface is incomplete. They will annotate their designs using feedback from others to identify improvements that could be made during the development stage. For example, feedback for an online booking system may suggest an improvement to how the password appears once entered, such as to hide the password or include an option to change the password.

Learners must develop their design using a range of customisation and integration technologies and techniques and carry out testing. The results of testing will demonstrate that some of the functionality of applications is incomplete, which means that the organisation's needs will not be fully met. For example, much of an online booking system will be functional, except the search option may not work and the password routine may not allow users to be added and/or change their password.

Overall, the evidence will be well structured and there will be some use of appropriate technical language, although there may be some inaccuracies with terms used and the design and development may be basic in parts. Also, some parts of the evidence may be considered in greater depth than others.

Links to other units

This unit links to:

- Unit 2: Creating Systems to Manage Information
- Unit 4: Programming
- Unit 5: Data Modelling
- Unit 7: Mobile Apps Development
- Unit 9: IT Project Management
- Unit 11: Cyber Security and Incident Management
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 18: The Internet of Things
- Unit 20: Business Process Modelling Tools.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used in the customisation and integration of software applications
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 15: Cloud Storage and Collaboration Tools

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore the uses of cloud technologies for storing and distributing data and apply cloud technologies that aid collaboration to meet a client's needs.

Unit introduction

Cloud services provide on-demand access to a shared pool of configurable computing resources, including network devices, servers, storage and applications that can be rapidly provisioned and released. As our reliance on mobile devices to access digital services and content grows, the use of 'The Cloud' as a method of storing and distributing data and services becomes more popular. It is likely that you have made use of these technologies yourself for tasks such as backing up images from your smartphone. The scope of cloud-based services is much wider than just storage, and it gives organisations and individuals flexibility in the way IT meets their needs, allowing them to shrink, expand or diversify their IT use while reducing the complexity and cost of making changes to existing processes and systems.

In this unit, you will learn about how different cloud-based technologies can be used to meet a range of clients' needs. You will explore the characteristics, benefits and drawbacks of these technologies, considering their impact on individuals and organisations. You will analyse the IT needs of an organisation and how cloud storage and collaboration tools will meet the organisation's needs. Finally, you will design and implement a cloud-based solution to meet a client's need.

The analytical skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment in a role that requires working as, and collaborating with, a team.

This unit provides partial coverage to content from the Microsoft Azure Fundamentals Certification.

Learning aims

In this unit you will:

A Explore the use of cloud technologies and tools in organisations

B Design and deploy a cloud-based collaboration service to meet a client's needs

C Manage and review a cloud-based collaboration service to meet a client's needs.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the use of cloud technologies and tools in organisations	**A1** Cloud computing in organisations **A2** Cloud computing models **A3** IT requirements of an organisation **A4** Impact of cloud services **A5** Legal requirements	A report investigating how cloud-based storage and collaboration solutions could be implemented in an organisation to fulfil its needs.
B Design and deploy a cloud-based collaboration service to meet a client's needs	**B1** Planning cloud-based collaboration solutions **B2** Reviewing and refining designs **B3** Development of cloud-based collaboration solutions	A project brief detailing client needs, design specifications for the proposed solutions, development and testing logs, meeting notes and a report that evaluates the effectiveness and appropriateness of the cloud storage and collaboration solution.
C Manage and review a cloud-based collaboration service to meet a client's needs	**C1** Testing and maintaining cloud-based collaboration solutions **C2** Reviewing and refining cloud-based collaboration solutions **C3** Lessons learned from developing cloud-based collaboration solutions **C4** Presentation skills **C5** Reviewing own skills, knowledge and behaviours applied	

Content

Learning aim A: Explore the use of cloud technologies and tools in organisations

A1 Cloud computing in organisations

The deployment, benefits and drawbacks of cloud technologies for organisations.

- The reasons for the use and deployment of cloud technologies in international organisations, including improved productivity, improved/diversification of service, improved user experience, reduced costs and more flexibility of service.
- The key characteristics of cloud computing:
  - on-demand self-service – the ability to deploy/alter services and resources as required with minimal assistance
  - ubiquitous access – storage access and/or processing capability from different devices in different geographical locations
  - resource pooling – the use of the same resources by multiple organisations
  - measured service – monitoring of which of the provider's services are used and how they are used
  - rapid elasticity – ability to scale (grow/shrink) resources available when required.
- The benefits and drawbacks to organisations of the key characteristics of cloud computing.

A2 Cloud computing models

The characteristics and scope of cloud computing models.

- The characteristics, requirements and implications of different types of cloud service:
  - Software as a Service (SaaS) – web-based applications for end users
  - Platform as a Service (PaaS) – a set of tools and services to help make developing and deploying applications more efficient
  - Infrastructure as a Service (IaaS) – hardware and software needed for a functioning system to operate.
- The link between virtualisation, containerisation and cloud services.
- The characteristics, requirements and implications of different cloud delivery models: community, hybrid, private and public.
- Self-host versus third-party services.
- The scope, characteristics and implications of cloud service models, including automation, cloud bursting, just-in-time service and multi-tenancy.

A3 IT requirements of an organisation

The aims, requirements and benefits of cloud computing to an organisation in comparison to their current systems:

- current IT systems used to meet the needs of the organisation and its customers
- the services an organisation provides and how cloud services can support them
- aims and goals of organisations in the context of cloud computing and how these may be met
- customers – needs, expectations, how product and/or service is delivered and what the benefits are

- staff needs, e.g. job requirements, accessibility requirements, working styles and patterns
- location – staff, customers, business premises, market and/or service delivery point
- local legal and ethical considerations
- requirements that cannot be met using current/available cloud-based services, e.g. production/manufacturing processes.

A4 Impact of cloud services

The implication of cloud computing services and solutions for individual users and organisations.

- The implications of cloud computing services and solutions for individual users:
  - uses and applications of cloud services
  - flexibility
  - cost
  - efficiency
  - risks, e.g. data availability, third-party ownership of data/servers
  - challenges, e.g. technical support, staff skills, staff training, implementation procedures.
- The implications of cloud services and solutions for organisations:
  - user experience, e.g. ease of use, performance, availability and accessibility
  - staffing issues, e.g. skills, training, individual needs, working patterns
  - cost, e.g. payment models (consumption-based, fixed price), training, infrastructure
  - implementation, e.g. choosing a solution(s), timescales, testing, migration to the new system
  - backup and disaster recovery
  - constraints, e.g. available bandwidth, restrictions enforced by filter software/firewalls
  - local legal and ethical considerations
  - data security, including:
    - differences between authentication and authorization, and when each should be used
    - tools and good practice for securing data, e.g. role-based access, multi-factor authentication, single sign-on (SSO)
  - service level agreements and their role in defining the scope of service provided
  - legal ownership of data and jurisdiction, including:
    - geographical location of service and data
    - data movement across borders
    - procedures when an agreement ends
  - dispute resolution, including:
    - statutory requirements
    - mediation or arbitration (voluntary and binding)
    - escalation path from initial dispute to final resolution
  - problems encountered by data and processing residing in multiple jurisdictions
  - issues relating to data and processing residing regions that may not have appropriate laws covering protection and use of data.

A5 Legal requirements

The content and scope of legislation and its impact on the use and deployment of cloud services by organisations:

- local legislation considerations.

Learning aim B: Design and deploy a cloud-based collaboration service to meet a client's needs

The requirements for documenting the cloud collaboration solutions planning process.

Plan and implement a cloud-based collaboration solution, using current applicable technologies.

B1 Planning cloud-based collaboration solutions

Planning documentation for cloud collaboration solutions, to include:

- purpose of solution
- client's requirements
- user needs
- technical requirements, including an assessment of the available infrastructure against client requirements and potential solution requirements, hardware, software and other resources required
- legal and ethical considerations
- risks and how these might be mitigated.

B2 Reviewing and refining designs

Understand the concepts of working with clients and others to improve the quality, effectiveness and appropriateness of designs, including:

- gathering feedback from client(s) and potential users
- communicating with clients, e.g. email, verbal communication
- scheduling and documenting meetings
- agreeing and adjusting timescales
- refining ideas and solutions, including the management of risks
- updating design specification documentation.

B3 Development of cloud-based collaboration solutions

Implementing cloud-based collaboration solutions to meet identified requirements, including:

- preparing physical and/or virtual infrastructure, e.g. server, deploying server operating system, initialising virtual server instance on third-party server, e.g. defining a virtual private cloud (VPC), selecting regions and availability zones, load balancers, resource groups
- preparing platform, e.g. guest operating system image, allocation of host computer resources
- securing the platform, e.g. secure keypairs, defining subnets and gateways, security groups, route tables, firewall configuration
- adding, removing and updating software, services and tools on the service
- user management, including setting up new users, password management, resource allocation, e.g. storage quotas, available tools and privileges and access rights, e.g. identity management, user groups

- installing/preparing 'cloud clients', e.g. browser plugins, mobile apps
- managing an effective collaboration: setting targets, agreeing protocols and roles and responsibilities of individual team members
- detailed documentation of the development process.

Learning aim C: Manage and review a cloud-based collaboration service to meet a client's needs

C1 Testing and maintaining cloud-based collaboration solutions

The use of appropriate testing methodologies to ensure cloud-based collaboration solutions meet their identified requirements.

- Different types of testing, e.g. functional, user, performance, and stress and security.
- Selecting suitable test users.
- Gathering feedback from users.
- Producing appropriate test documentation.
- Making use of testing outcomes.
- Continued maintenance.

C2 Reviewing and refining cloud-based collaboration solutions

Monitoring performance of cloud-based solutions and making updates and changes as needed:

- security issues and updates, e.g. applying patches, responding to threats/breaches
- software updates, e.g. upgrading operating systems/application software
- compatibility issues, e.g. access by different operating systems, browser/plug-in compatibility
- changing user requirements, e.g. diversification of service, adding additional functionality to cloud service
- hardware developments, e.g. support for different interface/input methods.

C3 Lessons learned from developing cloud-based collaboration solutions

The process of evaluating the effectiveness of the solutions that have been developed, with reference to:

- how far the solution met the identified client's requirements
- efficiency of the solution
- ease of use
- issues arising during testing and maintenance
- stability
- potential update schedule
- how the implemented solutions could be improved to better meet the needs of the user and fulfil the identified needs
- alternative solutions that could be implemented if the task was to be repeated.

C4 Presentation skills

The requirements of presentation skills for implementing cloud-based collaboration solutions.

Communication requirements:

- media conventions and requirements to convey intended meaning, e.g.:
  - written, including email, design documentation, recording documentation, reports, visual aids for presentation use
  - verbal communication requirements, including one-to-one and group informal and formal situations
- use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical and vocational language suitable for intended audience, and the avoidance of jargon
- responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

C5 Reviewing own skills, knowledge and behaviours applied

The skills, knowledge and behaviours required when implementing cloud-based collaboration solutions.

- Planning and recording opportunities for skills, knowledge and behaviours development, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills knowledge and behaviours development, including the use of feedback from others.
- Own behaviours and their impact on outcomes, to include professionalism, etiquette, support of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating targets set for skills, knowledge and behaviour development to obtain insights into own performance.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Explore the use of cloud technologies and tools in organisations</td><td rowspan="2">A.D1 Analyse the impact that different cloud technologies would have on an organisation and how it could meet their needs.</td></tr>
<tr><td>A.P1 Explain how IT is currently deployed in an organisation and how it meets their needs.
A.P2 Explain the different cloud technologies that could be used by an organisation and how it could meet their needs.</td><td>A.M1 Compare the impact that different cloud technologies would have on an organisation and how it could meet their needs.</td></tr>
<tr><td colspan="2">Learning aim B: Design and deploy a cloud-based collaboration service to meet a client's needs</td><td rowspan="4">BC.D2 Evaluate the plan and optimised solution against a client's needs.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of cloud storage and collaboration solutions.</td></tr>
<tr><td>B.P3 Produce plans for a cloud storage and collaboration solution to meet a client's needs.
B.P4 Develop a cloud storage and collaboration solution to meet a client's needs.</td><td>B.M2 Justify planning and implementation decisions, including risks, showing how they will provide an effective solution to meet a client's needs.</td></tr>
<tr><td colspan="2">Learning aim C: Manage and review a cloud-based collaboration service to meet a client's needs</td></tr>
<tr><td>C.P5 Test and manage a cloud storage and collaboration solution, confirming that it meets the client's needs.
C.P6 Review the extent to which the cloud storage and collaboration solution meets the client's needs.</td><td>C.M3 Optimise the cloud storage and collaboration solution to meet the client's needs.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use the tools and techniques (given in the unit content) to design and develop cloud storage and collaboration solutions. The solutions can be created using live hosted resources (self-hosted or using third-party servers) or simulated using virtual machine(s).

There is a range of commercial and open source resources available, some of which are free and others are paid for. This unit does not recommend any particular technology.

Essential information for assessment decisions

Learning aim A

Learners' evidence should show understanding of cloud technologies through analysis of a real organisation's requirements. Learners must only use organisations that have no or limited adoption of cloud technologies as part of their exploration study.

For Distinction standard, learners will produce a clear and balanced analysis, supported by fluent and accurate technical language, of how the characteristics of the different cloud technologies and delivery models could be used to meet an organisation's IT needs. Learners will give a clear, accurate and robust analysis of how different services and solutions would impact on all areas of the organisation, providing a clear, reasoned justification as to why one suggested solution may be preferable to another.

Overall, learners must give a balanced consideration of the impact that cloud technologies would have on the organisation, both in terms of enhancing and improving current practice and how this will result in changes or challenges. For example, the consideration of risks to their data and operations created through the use of cloud technologies.

For Merit standard, learners will show a clear understanding in their evidence of how the characteristics of cloud technologies and delivery models could be used and implemented in the identified organisation. Learners will give a clear, accurate and robust comparison of how the solutions would impact on an organisation, making justified suggestions as to why one type of solution may be preferable to another.

Overall, learners will show they have considered the impact cloud technologies will have on the organisation and how this will result in changes or challenges, for example, the consideration of risks to their data and operations, drawing comparisons between different solutions and services. The comparison and consideration of the impact is likely to be unbalanced, for example they may focus more on the positives than the negatives. The report will be technically accurate and demonstrate good-quality written communication.

For Pass standard, learners will give an explanation of the IT systems currently used by an organisation and how these support the organisation and its users. The organisations used in learners' exploration study must have no or limited adoption of cloud technologies.

Learners will give explanations of the characteristics of different cloud technologies and delivery models, and the descriptions will be supported by examples of how these could be implemented to replace and/or support current IT systems.

Overall, learners will demonstrate an understanding of the resource requirements of the identified uses and how these might impact, both positively and negatively, on the needs of the organisation. The report may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners' evidence should identify and develop cloud storage and collaboration solutions to meet a client's needs. The solutions can be created using live hosted resources (self-hosted or using third-party servers) or simulated using virtual machine(s).

Centres should ensure that the problems give enough scope to allow learners to develop a solution that meets a range of user and organisational needs.

For Distinction standard, learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the design, development, maintenance, optimisation and testing of the solution impacted on their effectiveness. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners will give a thorough evaluation of the effectiveness of the final solution, including comparisons to possible alternatives, which will be supported by evidence from all stages of the project to reach valid conclusions and suggest future actions and developments.

The evaluation will contain a systematic and accurate review of their own skills, performance and the impact that this had on the effectiveness of the solution. Evaluation evidence of behaviours will demonstrate learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with others, including the client and test users, as well as time management. Where possible, learners should refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For Merit standard, learners will apply their knowledge through selection and application of appropriate methodologies to design, develop, maintain and test effective, optimised cloud storage and collaboration solutions to meet a client's needs.

Learners will give a clear and balanced analysis of the success of their solution, giving an accurate and reasoned rationale for decisions made when designing and implementing the solution to meet the client's needs, and how these affected the final outcomes. Learners should show they have considered potential risks to the client and their data, which may be present due to the nature of the deployment, and what measures have been taken to reduce the impact of them on the company.

Learners will implement the solution and monitor it over time, analysing how the solution performs and meets user needs. Using the results of testing and reviews, learners will optimise the cloud collaboration solution that they have created so that it better meets the client requirements. The optimisation could include adjustment of the security or performance of the system, adding additional features, and upgrading software.

For Pass standard, learners will apply understanding through the planning and development of a cloud storage and collaboration solution to meet a client's needs. The plans will explain the requirements of the solution and provide technical specifications for the suggested solution.

Learners will give evidence that they have deployed appropriate services and set up and managed users of the system. For example, learners may choose to make use of a free cloud server deployment that comes with an operating system pre-installed, on to which they would install/deploy their solution. The solution may involve sharing and collaborating on documents and/or code. Or they may choose to install a base OS themselves on to a third-party hosted (or self-hosted) server, which may take slightly longer to deploy initially but may give greater control over the available features, such as personalisation of desktop, applications and files, and allow them to remove unnecessary components to improve efficiency and performance.

Learners will carry out and document a number of tests and reviews of the solution to ensure that it works and meets the identified criteria. They will provide evidence that they have managed the solution over a period of time, such as over a two-week period. The time period must be sufficient to allow them to carry out basic maintenance procedures and apply important updates and changes as required. They will provide evidence that they have performed basic maintenance to the solution over a period of at least two weeks and will apply important changes and updates as required.

This could include adding users, adding and removing features, and updating software. The implemented solution will work as intended but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be.

Learners will review how the decisions they made during planning and development affected the final solution, explaining to what extent they met the initial project briefs. They will consider both positive and negative aspects of the solution, although their review may be unbalanced and/or superficial. They will make reference to possible alternative solutions that could be implemented and will make suggestions as to how the solution could be improved if the task was repeated.

Links to other units

This unit links to:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 2: Creating Systems to Manage Information
- Unit 6: Website Development
- Unit 11: Cyber Security and Incident Management
- Unit 12: IT Technical Support and Management
- Unit 13: Software Testing
- Unit 14: Customising and Integrating Applications.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop cloud storage and collaboration tools
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 16: Digital 2D and 3D Graphics

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore the purpose and characteristics of digital graphics and use software tools to design and create a digital graphic that could be used in other media products.

Unit introduction

Two-dimensional (2D) and three-dimensional (3D) digital graphics are used in a variety of ways, from basic elements of a user interface to being included in other media products, such as websites, printed media (such as advertising posters) and computer games. Good planning, production and manipulation of digital content is essential to ensure that digital products are consumed by their intended audience and are fit for purpose.

In this unit, you will understand the difference between raster- and vector-based graphics. You will investigate the purpose and characteristics of different 2D and 3D digital graphics. The characteristics you will explore are technical characteristics, including how graphics are created and represented in digital form, and the local legal requirements. You will also explore the impact of the technologies used on the usability and accuracy of the digital graphics. You will design and develop 2D and 3D digital graphics for an audience and purpose. To do this you will use specialist software and hardware to develop the graphics that could be included in a larger media product, such as a user interface, a website or a computer game.

The visual communication, planning and design skills you gain in this unit will prepare you for entry to higher education to study a range of degrees. The unit will also help you when entering an IT apprenticeship or the workplace.

Learning aims

In this unit you will:

A Investigate the purpose and characteristics of digital graphics that are an important part of visual communications

B Design 2D and 3D digital graphics products to meet a client brief

C Develop 2D and 3D digital graphics products to meet a client brief.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the purpose and characteristics of digital graphics that are an important part of visual communications	**A1** Purpose of and legal requirements for digital graphics **A2** Representation and applications of 2D and 3D digital graphics **A3** Hardware and software tools for digital graphics	A report or detailed presentation on the purpose and technical characteristics of, and legal considerations for, 2D and 3D digital graphics.
B Design 2D and 3D digital graphics products to meet a client brief	**B1** Planning digital graphics **B2** Design documentation for digital graphics **B3** Digital graphics processing and techniques **B3** Reviewing and refining designs	A design specification showing the planning and design of 2D and 3D digital graphics products that could be used in a larger media product. Digital graphics files that fulfil the design specifications, accompanied by supporting development documentation. An evaluation of the digital graphics against the client's brief. A record of personal performance while completing the activity, such as whether work was submitted on time.
C Develop 2D and 3D digital graphics products to meet a client brief	**C1** Tools and techniques for developing digital graphics **C2** Reviewing the final 2D and 3D digital graphics products **C3** Professional behaviours	

Content

Learning aim A: Investigate the purpose and characteristics of digital graphics that are an important part of visual communications

A1 Purpose of and legal requirements for digital graphics

The purpose and legal requirements for digital graphics.

- The purpose of digital graphics is to:
  - convey information, messages and meaning to an audience, including a target market, customer and/or user
  - visualise, communicate, verify and evaluate potential ideas, solutions, intentions, requirements and alternatives to an audience.
- The current and relevant local legal requirements for digital graphics.

A2 Representation and applications of 2D and 3D digital graphics

The application and principles of 2D and 3D in digital graphics.

- Two types of digital graphic, raster- and vector-based, and the differences between them:
  - raster image principles
    - 2D arrays
    - resolution, e.g. pixel and spatial
    - dimensions
    - sampling
    - bit depth
    - colour modes
  - applications of raster-based 2D images, including image compositing for website graphics, print advertising, packaging and creating assets for computer games
  - vector image principles
    - geometrical primitives, including points, lines, curves, and polygons
    - nodes
    - paths
    - voxel
  - applications of vector-based 2D images, including user interfaces, logos, illustrations, buttons for interactive media products, icons, fonts, magazine design and creating assets for computer games.
- Principles and applications of representing 3D images in digital format, including:
  - geometric theory
    - vertices
    - line
    - curve
    - edge
    - polygon
    - mesh, e.g. wireframe
    - coordinate geometry
    - mesh construction:
      box modelling
      extrusion modelling
      primitives, e.g. cube, sphere

  - rendering
    - lighting
    - radiosity
    - ray tracing
    - pixel shading
    - level of detail
    - rasterising, including scan conversion.
- Applications of 3D images, including landscapes, architecture, objects and characters for computer and video games, virtual reality, animation, motion/broadcast graphics, simulations, visualisations and special effects.
- Impact of the 2D and 3D digital graphic representation principles on their usability and accuracy, e.g. dimensions, scalability, colour management, rasterising, rendering, quantisation, anti-aliasing.

A3 Hardware and software tools for digital graphics

The principles and application of hardware and software tools used in the development of 2D and 3D graphics and how they affect development and the completed graphics, including:

- capture
  - camera, e.g. image sensor, connectivity, modes, composition, angle
  - scanner, e.g. resolution, file type, colour format
  - graphics tablet, e.g. pens, pencils, brushes
- graphics card
  - random-access memory (RAM)
  - cache
  - processor
- output
  - screen, e.g. cathode ray tube (CRT) and liquid crystal display (LCD)
  - print, e.g. printer resolution
- software applications for manipulating graphics
  - vector based, e.g. Inkscape, Adobe Illustrator®
  - raster based, e.g. GIMP, Adobe Photoshop®
  - 3D image editors, e.g. Blender™, Maya™
  - image galleries
  - file conversion
- impact of the hardware and software tool selection on the digital graphic usability and accuracy, e.g. export ratios, compressions, channels, file format, proofing, testing, combining raster and vector graphics, image manipulation techniques.

Learning aim B: Design 2D and 3D digital graphics products to meet a client brief

B1 Planning digital graphics

The processes and techniques to consider when planning the production of digital graphics to suit required specifications, including:

- sources of stimulus, e.g. client brief, own brief and research
- techniques for generating ideas, e.g. brainstorming, mood boards, and thumbnail sketching
- quality characteristics, e.g. image quality, compatibility
- processing and editing techniques
- file and compression formats.

B2 Design documentation for digital graphics

The requirements for documenting the digital graphic design process.

- Design brief, including:
  - requirements of the brief
  - target audience
  - purpose
  - client requirements.
- Research, e.g. market research, process planning.
- Visual themes and aesthetics:
  - ergonomics
  - anthropometrics
  - virtual and physical.
- Local legal and ethical considerations, including:
  - copyright
  - accessibility
  - ethical issues, e.g. confidentiality
  - representation, e.g. race, gender, religion, sexuality
  - decency
  - intellectual property rights.
- File naming and storage location.
- Sources of images.
- Sketches, e.g. concept sketches, 2D and 3D drawings.
- Intended platform for delivery.
- Hardware requirements, including:
  - specification of target platform, e.g. graphic capability, screen resolution
  - input devices, e.g. camera, scanner.
- Software requirements, including:
  - tools required
  - target file formats
  - product compatibility.
- Ready-made assets, e.g. photograph, image, logo.

B3 Digital graphics processing and techniques

The purpose, use and impact of the processing and techniques involved in designing digital graphics, including:

- graphic processing and editing:
  - rotation
  - scaling
  - translation
  - 3D viewing
  - file sizes, e.g. image quality, cropping
- compression techniques, e.g. lossless and lossy compression, resolution, colour depth
- user experience:
  - quality, e.g. quantisation levels, sampling resolution
  - compatibility, e.g. graphic style, combination of typographic and graphic elements
  - usability, e.g. layout, colour combinations
  - hardware requirements, e.g. anisotropic filtering
  - software requirements, e.g. style sheets, layer styles, master pages, templates.

B4 Reviewing and refining designs

The implications of working with a client to improve the quality, effectiveness and appropriateness of the designs:

- working with clients and others to improve the quality, effectiveness and appropriateness of designs
- gathering feedback from clients and users
- communicating with clients
- updating design specification based on feedback.

Learning aim C: Develop 2D and 3D digital graphics products to meet a client brief

C1 Tools and techniques for developing digital graphics

The use of tools and techniques to create digital graphics.

- 2D graphic tools:
  - freehand draw
  - transformations
  - grouping colour balance
  - filters
  - selection
  - hue and saturation
  - masking
  - layering
  - retouching
  - opacity/transparency
  - editing and combining paths
  - typography.

- 3D graphic tools:
  - geometric models, e.g. cube, sphere
  - mesh, e.g. vertices, polygons
  - modelling layers, e.g. modify, extend, extrude
  - Non-Uniform Rational Basis Spline (NURBS), e.g. relational modelling, curves, surface approximation
  - virtual camera, e.g. field of vision, depth of field
  - lighting, e.g. ambient, linear
  - texturing, e.g. creating, loading, applying texture maps, including colour maps, bump maps, normal maps, displacement maps, specular maps
  - rendering, e.g. scene, size and aspect, image resolution, file size.

C2 Reviewing the final 2D and 3D digital graphics products

Evaluating the effectiveness of the solutions that have been developed, with reference to:

- how far the solution meets the client's requirements (brief), including audience and purpose
- quality of digital graphics, e.g. scale, design principles including: composition, balance, emphasis, contrast
- local legal and ethical constraints
- technical constraints, e.g. file formats and model constraints, including:
  - polygon count and texture size
  - strengths and weaknesses
- optimising digital graphics, e.g. removing surplus geometry and triangulation, bit depth, resolution, dimensions, compression
- how the digital graphic products could be improved to better meet the needs of the user and fulfil the identified needs.

C3 Professional behaviours

The skills, knowledge and behaviours required when implementing digital graphics products.

- Planning and recording opportunities for skills, knowledge and behaviours development, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills, knowledge and behaviours development, including the use of feedback from others.
- Own behaviours and their impact on outcomes, to include professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating targets set for skills, knowledge and behaviour development to obtain insights into own performance.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate the purpose and characteristics of digital graphics that are an important part of visual communications</td><td rowspan="2">A.D1 Evaluate the purpose and characteristics of different digital graphic products, including how they impact on their usability and accuracy.</td></tr>
<tr><td>A.P1 Explain the purpose and legal considerations for different digital graphic products.
A.P2 Explain the technical characteristics of different digital graphic products, including a limited explanation of how they impact on their usability and accuracy.</td><td>A.M1 Discuss the purpose and characteristics of different digital graphic products, including how they impact on their usability and accuracy.</td></tr>
<tr><td colspan="2">Learning aim B: Design 2D and 3D digital graphics products to meet a client brief</td><td rowspan="3">BC.D2 Evaluate the 2D and 3D digital graphics product designs and the optimised product solutions against the client's brief.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of digital graphic products.</td></tr>
<tr><td>B.P3 Produce designs for 2D and 3D digital graphic products to meet the client's brief.
B.P4 Review the designs for 2D and 3D digital graphic products to identify and inform refinements.</td><td>B.M2 Justify design decisions for 2D and 3D digital graphics products, showing how they will provide effective solutions to meet the client's brief.</td></tr>
<tr><td colspan="2">Learning aim C: Develop 2D and 3D digital graphics products to meet a client brief</td></tr>
<tr><td>C.P5 Develop 2D and 3D digital graphic products to meet the client's brief.
C.P6 Review the extent to which the 2D and 3D digital graphic products meet the client's brief.</td><td>C.M3 Optimise the 2D and 3D digital graphic products to effectively meet the client's brief.</td><td></td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use a selection of tools and techniques, as given in the unit content, to produce 2D and 3D digital graphics.

There are a number of propriety and open source resources available, including:

- image-editing software, e.g. Photoshop, Pencil, Synfig Studio
- 3D-modelling software, e.g. 3D Studio Max®, Maya, Modo™, ZBrush®, AutoCAD®, Cinema 4D™, Blender.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will provide a clear and balanced evaluation of how the technical characteristics of the digital graphics impact on their purpose, usability and accuracy. Learners' enquiries will lead to a supported judgement, showing relationship to its context. For example, learners may evaluate how a particular computer game may use a polygon scan conversion algorithm because it is fast and interactivity is an important aspect of the user experience, whereas ray tracing is used to create special effects in certain films because it can produce more realistic looking images. Learners' evaluations will cover a range of 2D and 3D digital graphics and they will evaluate other characteristics such as any local legal requirements that may apply and the purpose of the graphics.

Overall, the evidence, such as a report, will be easy to read and understand by a third party. It will be logically structured and logical chains of reasoning will be used to support different aspects of the evaluation. They will use appropriate technical language throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will discuss the purpose of, and local legal requirements for, different digital graphic products. They will also discuss the technical characteristics, both how the image is represented digitally and what hardware and software tools were probably used, to create 2D and 3D digital products. Learners' discussions will cover how the technical characteristics interrelate and the extent to which they impact on the accuracy of the graphic, for example how pixel and spatial resolution interrelate and how they impact on the accuracy of an image.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will explain the purpose of, and local legal requirements for, different 2D and 3D digital products. For example, learners may explain that the purpose of graphics in a computer game is to entertain users and that one of the local legal requirements is copyright.

Learners will explain the technical characteristics of the graphics, including how images are represented electronically, and will explain what hardware and software tools were probably used to create and manipulate them. They will consider how digital images are stored, manipulated and used, and may identify some of the technical processes that are used in digital graphic production and the effect this has on digital images. For example, learners may explain the difference between lossless and lossy compression.

Overall, the evidence will be well structured with some use of appropriate technical language, although there may be some inaccuracies with terms used and it may be basic in parts. Some parts of the evidence may be considered in greater depth than others. For example, if present, any explanation of how the technical characteristics impact on their usability and accuracy will be limited.

Learning aims B and C

Learners must provide evidence of the design and development of at least one 2D and one 3D digital graphic product. Depending on client requirements, the products may be suitable for inclusion in a larger media product. For example, a computer game may require characters, objects and background digital graphics.

For Distinction standard, learners will evaluate their digital graphic images, using feedback and comparison against the client's requirements, to justify their design solutions in comparison to alternative approaches. For example, different types of 'normal maps' could be used in the design of a 3D graphic image by using feedback that a 'tangent space normal map' is best suited to designing characters, whereas for assets that don't need to deform, an 'object space normal map' could be used. Learners will evaluate the effectiveness of the graphics processing and techniques chosen as part of their design, providing reasoned justifications for their choices and evaluating their impact on the final outcomes.

They will develop and optimise their digital graphic products using a wide range of tools and techniques, and will effectively meet the client's requirements. Throughout the development process, they will evaluate the products and decisions taken, providing reasoned justification of the decisions taken and why changes have been made.

Overall, the evidence will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources. Learners will reflect on their own performance during the design and development of 2D and 3D digital graphics, with evidence demonstrating their effectiveness in individual responsibility, creativity and self-management. For example, for creativity, learners' evidence could demonstrate that each digital graphic image will combine assets imaginatively, demonstrating a clear understanding of design principles, audience and purpose.

For Merit standard, learners will design digital graphic products, justifying their design decisions and demonstrating how the designs will result in an effective solution. For example, the design of a 3D graphic image may include a 'normal map' rather than a 'bump map' because although they both create the illusion of depth on the surface of a model, the 'normal map' uses red, green and blue (RGB) colour information that corresponds directly with the X, Y and Z axis in 3D space, which leads to more detailed information onto the surface.

Learners will develop their digital graphic products through the appropriate use of 2D and 3D image creation tools, techniques and formats. During the development process, learners will optimise their solutions to produce digital graphics that effectively meet the client's requirements. The product optimisation should consider the following points: accuracy, usability, compatibility and stability of the products, for example reducing the bit-depth of a 2D graphic image from 24 bits to a smaller colour palette for simple graphics such as user interface elements. The review will explain the extent to which the outcomes meet the client's requirements.

Overall, the evidence will be logically structured, technically accurate and easy to understand. Learners will provide evidence of the appropriate use of behaviours being applied during the project, for example learners' work will have been handed in on time and they will effectively seek and respond to feedback from others.

For Pass standard, learners will design at least one 2D and one 3D digital graphic product, using appropriate processes, to meet a client brief. The designs will include original digital assets and may also include some ready-made digital assets from other sources. Learners will produce designs that clearly outline the purpose of the digital graphics and will consider local legal and ethical issues related to sourcing and producing digital content and assets. Learners will consider the appropriateness of different possible tools, techniques and formats and the impact these would have on user experience.

They will annotate their designs using feedback from others to identify improvements that could be made during the development stage. For example, a bump map could be added to a 3D graphic image following feedback from others, to create the illusion of depth on the surface of the model.

Learners will develop at least one 2D and one 3D digital graphic product, containing original digital assets and possibly some ready-made digital assets from other sources. They must identify the source and obtain any ready-made assets, demonstrating an understanding of the implications of relevant local legal and ethical issues in their selection and use of particular content. Learners will produce 2D and 3D digital graphic products that meet the vast majority of the requirements from the client's brief. There may be small issues where the graphics do not meet the brief and issues of optimisation and/or rendering may not be addressed. For example, learners may not have complied with the stipulation in the design brief that the digital graphics must be presented in a file format that supports transparency.

Learners must review whether their digital graphic products meet the client requirements, considering both positive and negative aspects of the outcomes. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented if the project was repeated.

Overall, the evidence will be well structured with some use of appropriate technical language, although there may be some inaccuracies with terms used. The evidence may be basic in parts and some parts of the evidence may be considered in greater depth than others. For example, the design work for the 2D digital graphics may be more effective than the 3D drawings, and although the review will identify strengths and weaknesses of the outcomes, these may not be related to the audience and purpose. There will also be evidence of some appropriate behaviours being applied during the project, for example learners may have produced a time plan to design and develop product, but may have failed to use it to control the timely submission of work.

Links to other units

This unit links to:

- Unit 6: Website Development
- Unit 7: Mobile Apps Development
- Unit 8: Computer Games Development
- Unit 14: Customising and Integrating Applications
- Unit 17: Digital Animation and Effects.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop digital graphics
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 17: Digital Animation and Effects

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore the purpose and characteristics of digital animations and effects and create an animation, including effects, such as audio, that may be used in other media products.

Unit introduction

Digital animation and effects are used in a variety of ways, from individual digital products to being included as part of other media products. Example applications include content for film, advertising, music videos, websites and computer games.

In this unit, you will investigate the purpose, local legal requirements and technical characteristics, for example techniques and principles, of different digital animation and effects products. You will explore how graphics are created and the impact of the technologies used on the digital animation and effects products. You will design and develop a digital animation and effects product for an audience and purpose. To do this, you will use specialist software and hardware to develop the digital product that could be included in a larger media product, such as a website or a computer game.

The communication, planning and design skills you gain in this unit will prepare you for entry to higher education to study a range of degrees. The employability and entrepreneurial skills will also be useful when entering an IT apprenticeship or the workplace.

Learning aims

In this unit you will:

A Investigate the purpose and characteristics of digital animations and effects that are an important part of communication

B Design a digital animation and effects product to meet a client brief

C Develop a digital animation and effects product to meet a client brief.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the purpose and characteristics of digital animations and effects that are an important part of communication	**A1** Purpose of and legal requirements for digital animations and effects **A2** Techniques for and principles of creating digital animations **A3** Principles of creating digital effects **A4** Hardware and software tools for digital animations and effects	A report on the purpose and characteristics of digital animation and effects products, including how the technical characteristics impact on the product. The characteristics include: local legal requirements, animation and effects principles, and hardware and software tools used to create the digital products.
B Design a digital animation and effects product to meet a client brief	**B1** Planning products incorporating digital animations and effects **B2** Design documentation for digital animations and effects products **B3** Reviewing and refining designs for animations and effects	A design specification showing the planning and design of an animation and effects product that could be used in a larger media product. Digital animations and effects files that fulfil the design specifications, accompanied by supporting development and testing documentation. An evaluation of the digital animation and effects product against the client's brief. The product may be developed for inclusion in a larger media product, such as a computer game. A record of personal performance while completing the activity such as whether work was submitted on time.
C Develop a digital animation and effects product to meet a client brief	**C1** Tools and techniques for digital animations and effects **C2** Creating a digital animation and effects product **C3** Testing animations and effects **C4** Reviewing the final digital animation and effects product **C5** Professional behaviours	

Content

Learning aim A: Investigate the purpose and characteristics of digital animations and effects that are an important part of communication

A1 Purpose of and legal requirements for digital animations and effects

Digital animation is concerned with the illusion of motion through the sequencing of images, and effects is concerned with adding digital special effects, for example audio, to an animation or other media product post-production.

- The purpose of digital animations and effects is to:
  - convey information, messages, entertainment and meaning to an audience, including a target market, customer, and/or user
  - visualise, communicate, verify and evaluate potential ideas, solutions, intentions, requirements and alternatives to an audience.
- The current and relevant legal requirements for digital animations and effects:
  - defamation
  - licensing requirements
  - use of ready-made content created by others.
- Know typical applications for digital animations and effects, e.g. advertising, film and television, music videos, idents and sequences, educational, simulation and digital games.

A2 Techniques for and principles of creating digital animations

The principles and function of animation techniques, including combining animation and live action, rotoscoping, wireframes for 3D animation, computer-generated imagery (CGI), and motion capture.

- Production techniques:
  - frame-by-frame, including number and frame rate
  - cel tracing/onion skinning, including frame range, onion skin outlines, editing multiple frames
  - key framing, including adding, removing, copying and adjusting key frames, modifying tweening and interpolation, setting key frame parameters
  - frame rate, including frame rate standards and variations
  - compression, including lossy and lossless, frame disposal, auto crop, resolution, quantisation, curve fitting
  - vector animation, including scalable components (vertices, edges, nodes, paths and vectors)
  - raster animation, including pixel data (colour, position, brightness)
  - file formats, including advantages and disadvantages.
- Modelling techniques:
  - basic vector shapes
  - photorealistic
  - flat colour
  - graduated tones
  - hand-drawn appearance.
- 3D techniques:
  - coordinate system, including specifying coordinate systems, e.g. world, local, working
  - object hierarchy, e.g. links, parent–child relationships

  - pivot points, including rotation and scaling
  - trajectories, including creating, adjusting and converting paths
  - kinematics, including inverse and forward kinematics
  - animation layers, including combining, integrating and merging layers
  - morphing, including vertex position and interpolation.
- Impact of the animation techniques and principles on the usability and accuracy of digital animation and effects products, e.g. movement, body mechanics, composition, frame rate, animated user interface elements, lightweight coding, improved user experience, loading speeds, responsive animations, closed captioning.

A3 Principles of creating digital effects

The principles of creating digital effects and the impact on usability and accuracy.

- Principles of creating visual effects:
  - motion tracking, including tracking the movement of objects and applying tracking data to other objects
  - motion capture, including recording movement and actions, 3D recreation, performance capture
  - compositing, including:
    - live action
    - animated
    - background
  - animated effects
  - augmented reality, e.g. video games, navigation devices, architecture
  - virtual reality, including virtual reality games and experiences, e.g. museum tours.
- Principles of creating audio effects:
  - synchronising audio, including lip-synching, onscreen movement, actions
  - mixing sound, including:
    - levels
    - normalisation
    - equalisation, e.g. peak, high shelf, low shelf, high pass, low pass
  - compressing sound recordings, e.g. remove flawed, repetitive, superfluous audio material
  - combining sound effects, atmospheric/ambient sound, music and dialogue.
- Impact of the visual and audio effects principles on the usability and accuracy of digital animation and effects products, e.g. software and hardware configuration, file formats, sound consistency, colour combinations, user engagement.

A4 Hardware and software tools for digital animations and effects

The principles and application of hardware and software tools used in the development of animation and visual effects and how they affect development and the finished product.

- Hardware:
  - capture, including camera, scanner, drawing tablet
  - graphics card, including random-access memory (RAM), cache, processor
  - output, including screen, holographic, virtual reality.

- Software:
  - 2D animation editors, e.g. Pencil2D, Adobe Animate®
  - 3D animation editors, e.g. Blender™, Maya™
  - visual effects editors, e.g. Windows Movie Maker®, Adobe Premiere®
  - audio effects editors, e.g. Audacity®, Adobe Audition®
  - file conversion, e.g. HandBrake, Adobe Media Encoder®.
- Impact of the hardware and software tool selection on the digital animation and effects product usability and accuracy, e.g. output format, rendering time, image resolution, frame rate, output size and aspect ratio, optimising colour depth.

Learning aim B: Design a digital animation and effects product to meet a client brief

B1 Planning products incorporating digital animations and effects

The techniques to consider when planning the production of digital animations and effects to suit required specifications, including:

- sources of stimulus, e.g. client brief, own brief and research
- techniques for generating ideas, e.g. brainstorming, mood boards, thumbnail sketching
- quality characteristics, e.g. image quality, compatibility
- processing and editing techniques
- compression formats.

B2 Design documentation for digital animations and effects products

The requirements for documenting and justifying the design process.

- Requirements of the brief, including audience, purpose and client requirements.
- Research, e.g. market research, technique planning.
- Product design, including:
  - story idea, e.g. plot synopsis, scene breakdown, style
  - characters, e.g. number of characters, character design
  - background imaging, e.g. visual style of environments and props
  - sound and effects, e.g. music, voice-over, sound effects, green screen, time lapse
  - pre-production paperwork, including scripts, storyboards, storylines, timeline storyboards, mood boards, mind maps
  - timings, key frames, frame numbering, frame naming and frame rates
  - perspectives
  - dope sheet for instructions for animation/filming
  - long sheet for running time and sequencing.
- Intended platform/media for delivery.
- Hardware requirements, to include:
  - specification of target platform, e.g. input, processing and output requirements
  - specialist input devices, e.g. motion capture, laser scanning, computed tomography (CT) scanner, microphone
  - specialist output devices, e.g. virtual reality, speakers
  - locater devices, e.g. absolute or relative, direct or indirect, discrete or continuous.

- Software requirements, to include:
  - tools required
  - target file formats, types and sizes
  - product compatibility
  - codecs.
- Ready-made assets that can be edited or transformed to become part of the product, including:
  - visual, e.g. film, images or logos
  - audio, e.g. music, sound effects, and speech.
- Test plans to check correctness, presentation, audio and visual timings, compatibility, fitness for audience and purpose and other quality characteristics.
- Local legal and ethical requirements, including:
  - copyright
  - release forms
  - ethical issues, e.g. confidentiality
  - representation, e.g. race, gender, religion, sexuality
  - decency
  - libel
  - intellectual property rights.
- Technical constraints, e.g. file types, storage, and software licensing.

B3 Reviewing and refining designs for digital animations and effects

The requirements for documenting and justifying the design process:

- gathering feedback from client(s) and potential users
- communicating with clients, e.g. email, verbal communication
- scheduling and documenting meetings
- agreeing and adjusting timescales
- refining ideas and solutions
- updating design documentation to reflect feedback.

Learning aim C: Develop a digital animation and effects product to meet a client brief

C1 Tools and techniques for digital animations and effects

The use of tools and techniques for the development of animations.

- Tools and techniques for animations, including:
  - frame rates
  - onion skinning
  - tweening
  - transitions
  - camera angles
  - movement
  - picture duration
  - walk cycles
  - lip-syncing
  - rotoscoping
  - rendering and compositing.

- Tools and techniques for effects:
  - colour correction and grading, e.g. exposure, colour matching, atmospherics
  - using adjustment layers to effect multiple layers
  - masks and track mattes
  - keying, e.g. scale and opacity
  - typography, e.g. titles, captions and credits
  - transitions, e.g. fades, dissolves, wipes, including editing transition parameters
  - motion stabilisation and tracking
  - filters, motion vectors and time-based effects
  - audio mixing, including volume, ducking, pan, level control
  - timeline editing, including importing assets, copy, paste, trim, adding transitions, cue points, markers
  - audio effects, including amplification, distortion, reverb, delay, echo
  - sound effects
  - trigger volume.
- Storing animations and effects:
  - file formats
  - compression
  - target device/platform
  - user requirements
  - quality characteristics.
- Storing and using other ready-made digital assets, e.g. audio, video, graphic.
- Hardware and software requirements.

C2 Creating a digital animation and effects product

The development of the digital animation.

- Originating ready-made assets, e.g. footage for compositing.
- Importing ready-made assets, e.g. footage.
- Management of original and ready-made assets.
- Combining layers and assets together.
- Adding visual and audio effects for specific purposes.

C3 Testing animations and effects

The application of formative and summative testing, including feedback from others.

- Testing digital animations and effects for functionality, compatibility, stability and acceptance.
- Testing digital products against the client brief and especially audience and purpose.
- Obtaining feedback from others.
- Making improvements to animations and effects in response to testing and feedback.

C4 Reviewing the final digital animation and effects product

The implications of working with a client to improve the quality and effectiveness of the digital animation.

- Quality of animations and visual effects.
- Suitability against the client brief, especially for audience and purpose.
- Local legal and ethical requirements.
- Technical constraints.
- Strengths and weaknesses.
- Optimising animations and effects.

C5 Professional behaviours

The skills, knowledge and behaviours required when implementing the digital animation.

- Planning and recording opportunities for skills, knowledge and behaviours development, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills, knowledge and behaviours development, including the use of feedback from others.
- Own behaviours and their impact on outcomes, to include professionalism, etiquette, support of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating targets set for skills, knowledge and behaviour development to obtain insights into own performance.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Investigate the purpose and characteristics of digital animations and effects that are an important part of communication		**A.D1** Evaluate the purpose and characteristics of different digital animation and effects products, including how they impact on the finished product.
A.P1 Explain the purpose of and legal requirements for different digital animations and effects products. **A.P2** Explain the technical characteristics of different digital animations and effects products, including a limited explanation of how they impact on the finished product.	**A.M1** Discuss the purpose and characteristics of different digital animations and effects products, including how they impact on the finished product.	
Learning aim B: Design a digital animation and effects product to meet a client brief		**BC.D2** Evaluate the digital animation and effects product design and optimised solution against the client's brief. **BC.D3** Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a digital animation and effects product.
B.P3 Produce designs for a digital animation and effects product to meet a client's brief. **B.P4** Review the design for a digital animation and effects product with others to identify and inform refinements.	**B.M2** Justify the digital animation and effects product design decisions, showing how they will provide an effective solution to meet the client brief.	
Learning aim C: Develop a digital animation and effects product to meet a client brief		
C.P5 Create a digital animation and effects product to meet a client brief. **C.P6** Test the digital animation and effects product against the client brief. **C.P7** Review the extent to which the final digital animation and effects product meets the client brief.	**C.M3** Optimise the animation and effects product, to effectively meet the client brief.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use a selection of tools and techniques, as given in the unit content, to produce animations and effects.

There are a number of propriety and open source resources available, including:

- animation software, e.g. Adobe Animate, SketchBook® Pro, Blender
- visual effect editing software, e.g. Movie Maker, Adobe Premier
- audio effect editing software, e.g. Adobe Audition, GarageBand, Audacity
- 3D-modelling software, e.g. 3D Studio Max®, Maya, Modo™, ZBrush®, AutoCAD®, Cinema 4D™, Blender.

Essential information for assessment decisions

Learning aims A and B

For Distinction standard, learners will provide a clear and balanced evaluation of how the characteristics of the animation and effects products impact on their purpose, usability and accuracy. Learners' enquiries will lead to a supported judgement, showing relationship to its context. For example, learners' evaluation may state that website designers usually avoid purely decorative animations in favour of animations that enhance usability, by guiding people to understand the user interface and that contemporary web animations use lightweight code, such as Cascading Style Sheets (CSS) and JavaScript, in order to run more quickly. Evaluations will cover a range of digital animation and effects products and learners will evaluate other characteristics, such as any local legal requirements that may apply, and the purpose of the animations and the visual and audio effects.

Overall, the evidence, such as a report, will be easy to read and understand by a third party. It will be logically structured and logical chains of reasoning will be used to support different aspects of the evaluation. They will use appropriate technical language throughout and a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will discuss the purpose and characteristics (local legal requirements, techniques, principles and hardware and software tools) of different digital animation and effects products. They will also discuss the technical characteristics, including techniques, principles and the hardware and software tools, which were probably used to create and manipulate the digital products. Learners' discussions will cover how the technical characteristics affect the finished products. For example, how the 3D animator requires an understanding of the principles of movement and composition in order to accurately represent the movement of body parts, which are always present in 3D animation, and that the quality of the image and the quantity of polygons will affect the time taken to render each frame.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will explain the purpose of, and local legal requirements for, different digital animation and effects products. For example, learners may explain that the purpose of a background animation in a website is to add excitement and movement and that one of the local legal considerations is copyright.

Learners will explain the technical characteristics of animation and effects products, including techniques, principles, and hardware and software tools, which were probably used to create the digital products. Their explanation will cover how the technical characteristics affect the finished products. For example, learners may explain that characters in 3D animations are digitally modelled on a screen and fitted with a skeleton that allows the animator to pose the character in certain key frames and then the computer performs a 'tweening' animation to interpret the movement in each frame between the key frames. The evidence will also explain how file formats affect digital animation and effects products and how these can be used.

Overall, the evidence will be well structured with some use of appropriate technical language, although there may be some inaccuracies with terms used and it may be basic in parts. Some parts of the evidence may be considered in greater depth than others. For example, if present, any explanation of how the technical characteristics impact on their usability and accuracy will be limited.

Learning aims B and C

Learners must provide evidence of designing and developing a digital animation and effects product. The digital animation must be enhanced through visual and/or audio effects and should be of sufficient complexity to show use of a range of appropriate processing techniques, as listed in the content. Depending on client requirements, the product may be suitable for inclusion in a larger media product. For example, a computer game, a mobile application or a website.

For Distinction standard, learners will evaluate their digital animation effects product, using feedback and comparison against the client's requirements, to justify their design solutions in comparison to alternative approaches. For example, a player in a computer game animation could be guided, inspired or intentionally misled by using feedback that sound effects could be planted to warn players of potential dangers, such as predators or a bottomless pit. Learners will evaluate the effectiveness of the animation and effects techniques chosen as part of their design, providing reasoned justifications for their choices and evaluating their impact on the final outcomes.

They will develop and optimise their animation and effects product using a wide range of tools and techniques, and will effectively meet the client's requirements. Throughout the development process, they will evaluate the products and decisions taken, providing reasoned justification for them and why changes have been made.

Overall, the evidence will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources. Learners will reflect on their own performance during the design and development of animation and effects, with the evidence demonstrating their effectiveness in individual responsibility, creativity and self-management. For example, for creativity, learners' animations could imaginatively combine music, sound effects, a voice-over and ambient sounds to enhance the visual engagement of the user.

For Merit standard, learners will design a digital animation effects product, justifying their design decisions and demonstrating how the designs will result in an effective solution. For example, adding ambient sound to the virtual world of a computer game enriches the atmosphere and using sound effects such as footsteps will create a more immersive experience for the player.

Learners will develop their animation and effects product through the appropriate use of animation and effects tools, techniques and formats. During the development process, they will optimise their solutions to produce an animation with effects that effectively meet the client's requirements. The product optimisation should consider the following points: accuracy, usability, compatibility and stability of the products. For example, reducing the image size of an animated GIF and selecting a reduced resampling option to optimise the animation. The review will explain the extent to which the outcomes meet the client's requirements.

Overall, the evidence will be logically structured, technically accurate and easy to understand. Learners will provide evidence of the appropriate use of behaviours being applied during the project, for example learners' work will have been handed in on time and they will effectively seek and respond to feedback from others.

For Pass standard, learners will design a digital animation and effects product using appropriate tools and techniques, to meet a client brief. The designs will include original digital assets and may also include some ready-made digital assets from other sources. They will provide a project brief that clearly outlines the purpose of the digital animation and effects product and will consider local legal and ethical requirements related to sourcing and producing digital content and assets. Learners will also consider the appropriateness of different possible tools and techniques and the impact these would have on meeting the client brief.

They will annotate their designs using feedback from others to identify improvements that could be made during the development stage. For example, sound effects could be added to a computer game animation following feedback from others, to enhance the realism of the gameplay.

Learners will develop their digital animation and effects product, containing original digital assets and possibly some ready-made digital assets, for example audio and video clips from other sources. They must identify the source and obtain any ready-made assets, demonstrating an understanding of the implications of relevant local legal and ethical requirements in their selection and use of particular content.

Learners will test their digital animation effects product against the client brief and the results will demonstrate that it meets the vast majority of the requirements. There may be small issues where the product does not meet the brief and issues of optimisation and/or rendering may not be addressed, for example rendering out the animation into a file format different from the one stipulated in the client brief.

Learners must review whether their digital animation and effects product meets the client requirements, considering both positive and negative aspects of the outcomes. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented if the project was repeated.

Overall, the evidence will be well structured with some use of appropriate technical language, although there may be some inaccuracies with terms used. The evidence may be basic in parts and some parts of the evidence may be considered in greater depth than others. For example, learners' storyboards may have helped to shape and refine the idea but it may lack detail and annotation, such as camera movements. There will also be evidence of some appropriate behaviours being applied during the project, for example learners may have produced a time plan to design and develop the product, but may have failed to use it to control on-time delivery.

Links to other units

This unit links to:

- Unit 6: Website Development
- Unit 7: Mobile Apps Development
- Unit 8: Computer Games Development
- Unit 16: Digital 2D and 3D Graphics.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop digital animation and effects
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 18: The Internet of Things

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners explore systems and services that make up the Internet of Things (IoT) and develop an IoT system or device using off-the-shelf hardware and programming techniques and constructs.

Unit introduction

The Internet of Things (IoT) is referred to as the next industrial revolution and is transforming the way we work, socialise and live our lives. The IoT is connecting together our physical world of everyday 'things' and the digital world. It involves a network of 'things', for example appliances, vehicles and wearable devices that are embedded with sensors and other electronics to gather, store and analyse data over the internet that meets a need by triggering action(s). For example, vehicle diagnostics involving the location of equipment, service options and the collection of real-time driver and machine data and asset tracking, or remote medical diagnostics of patients involving their historical records being analysed with real-time data so that healthcare professionals can provide accurate diagnosis and treatment.

In this unit, you will investigate the applications of different IoT systems and services, including the principles involved and the characteristics of the systems and services. You will design a prototype IoT system or device and develop it using off-the-shelf hardware and suitable programming languages, techniques and constructs.

The analytical, problem-solving and practical skills you gain in this unit will prepare you for entry to higher education to study a range of degrees. The unit will help you when entering an IT apprenticeship or the workplace, for example as a junior software developer.

Learning aims

In this unit you will:

A Examine systems and services that form part of the Internet of Things

B Develop a design for an Internet of Things system or device to solve a problem

C Carry out the prototyping of an integrated Internet of Things system or device to solve a problem.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Examine systems and services that form part of the Internet of Things	**A1** Purpose and applications of systems and services that make up the IoT **A2** Principles that underpin IoT systems and services **A3** Characteristics of systems and services that make up the IoT	A written or video report investigating the systems and services that make up the IoT. Learners will cover the purpose, applications, principles and characteristics of systems and service that make up the IoT.
B Develop a design for an Internet of Things system or device to solve a problem	**B1** IoT system or device design process and documentation **B2** Machine-to-machine (M2M) system and device architecture **B3** Technical standards for IoT systems and devices **B4** M2M system and device communication requirements **B5** Security of IoT systems and devices	A system or device design portfolio containing the annotation and illustration of the architecture, communication requirements, addresses and security protection measures, including a comparison of alternative solutions. The development of a prototype IoT system or device with screen grabs, videos, photos and reports for the raw data collected and the results of processing and analysis of the data.
C Carry out the prototyping of an integrated Internet of Things system or device to solve a problem	**C1** M2M integrated system or device operations **C2** Programming techniques and constructs **C3** IoT analytics	

Content

Learning aim A: Examine systems and services that form part of the Internet of Things

A1 Purpose and applications of systems and services that make up the IoT

- The purpose of systems and services that make up the IoT is to improve:
  - productivity, e.g. in manufacturing organisations by allowing the analysis of processes in real time and using historical data to reduce downtime and ensure product conformity
  - safety and security, e.g. in the home by allowing the monitoring of household systems remotely such as intruder alarms and providing connectivity with emergency services
  - efficiency and effectiveness, e.g. by enabling the monitoring and analysis of air and water
  - the experience and satisfaction of users by solving new and existing problems using technology, e.g. through the monitoring and control of heating systems.
- The application of IoT systems and services in different sectors:
  - home, including:
    - energy monitoring and control systems
    - entertainment, e.g. motion tracking in video game controllers and mobile devices
  - health and wellbeing, including:
    - aiding and promoting good health, e.g. wearable devices
    - monitoring of vital signs, e.g. pacemakers, and heart rate monitors
  - industrial and transportation, including:
    - machine control, e.g. to optimise machine performance in manufacturing
    - road tolling, e.g. the electronic road toll passes using automatic number plate recognition systems and radio frequency identification (RFID) technologies
  - retail and commerce, including:
    - tracking and tracing objects and people in the supply chain, e.g. order fulfilment and returns
    - advertisement and consumer involvement.

A2 Principles that underpin IoT systems and services

The principles that underpin common IoT systems and services, including:

- the collection and analysis of data to trigger an action that results in a need being met
- a reliance on the existing internet and telecommunications infrastructure that allows IoT systems and services to operate
- access to and/or analysis of real-time data before it is transmitted back to the cloud or server
- access to and/or analysis of analogue data from the physical and natural world, e.g. light, sound, current, radio waves, humidity, vibrations, wind, video, pressure and time
- always-on connectivity that allows continuous monitoring of data from the physical world

- the spectrum of insight, coving the five-phase data flow in real time (in motion, early life, in rest and archive) and where data is processed at the point of collection in real time all the way to where archived data is used for modelling and analysis.

A3 Characteristics of systems and services that make up the IoT

- The general characteristics of IoT systems and services:
  - risks, including security threats, e.g. hacking of connected cars allowing the intruder to operate a vehicle remotely and the extraction of names and financial account numbers from contactless payment services without authentication from the owner
  - ethical and privacy considerations, including public and professional attitudes, opinions and behaviours towards IoT and a reduction of low-skilled employment opportunities
  - local legal considerations, e.g. use of data collected without consent and cybercrime and data protection
  - sustainability considerations, e.g. power requirements, recycling and reuse of components
  - benefits, including energy efficiency, e.g. transportation and in buildings, productivity gains, e.g. optimisation of processes in manufacturing, and agriculture, e.g. disease control and water use.
- Understanding the technical characteristics of IoT systems and services:
  - low mobility when a device has low or no mobility during its lifetime or mobility during a specific region. It often applies to systems and/or devices with specific functions, e.g. payment, metering, point-of-sale kiosks or remote maintenance
  - time controlled, where data is exchanged at certain predefined time periods and most applications have uses of time control
  - monitoring to detect events or actions rather than the security of the device
  - low power consumption, including extremely low consumption over long periods of time, infrequent user interactions and no constant power sources
  - location-specific trigger, including waking the device in a specific area or location.

Learning aim B: Develop a design for an Internet of Things system or device to solve a problem

B1 IoT system or device design process and documentation

Understanding the steps involved in developing a design for an IoT system or device to solve a problem, including:

- problem definition statement containing requirements: intended audience, full summary of the problem to be solved, constraints, benefits and nature of user interactivity and requirements, e.g. location-based and accessibility considerations
- purpose requirements as defined in a client brief
- initial design ideas/prototypes that illustrate the design principles and the requirements for an IoT system or device, including:
  - diagrammatic illustrations, e.g. system schematic and node block diagram
  - written annotations and commentary on intended operation
  - alternative design ideas, including commentary on why they were not chosen as the preferred idea

- identifying technical and design constraints, e.g. connectivity, memory storage, and power requirements and working around them
- obtaining and using feedback from others to improve the quality, effectiveness and appropriateness of the design
- decisions and processing steps, e.g. flow chart.

B2 Machine-to-machine (M2M) system and device architecture

The architecture of M2M communications in IoT systems and devices, including:

- sensors – when they might be used and how their data is translated in the system (from analogue to digital, from raw format to a readable, compatible format), including speed, suspension, pressure, and temperature and emission sensors
- wired and wireless communications – how they work and how they are used in IoT, including General Packet Radio Service (GPRS), Wi-Fi, Ethernet and Bluetooth® low energy (BLE), RFID and Quick Response (QR) codes
- actuators – how they are used in IoT, e.g. controllers, motors and servos
- device domain that provides communications between components – how they are used in IoTs, e.g. personal area networks
- network domain provides the communications between M2M gateways and M2M applications, e.g. wide area network (WAN) and wireless local area network (WLAN)
- application domain provides the middleware layer where data is used by business logic layers for processing to target the end user and customer, e.g. billing functions and customer care.

B3 Technical standards for IoT systems and devices

The adherence to current and relevant industry and internet standards set out by standards organisations, including the International Organisation for Standardisation (ISO), LoRa Alliance and the Institute of Electrical and Electronics Engineers (IEEE), to include:

- M2M interfaces, including the client-server ISO (Z39.50/ISO 23950), standard XML-focused search protocol (SRU), low barrier mechanism for metadata harvesting (OAI-PHM)
- reference frameworks, including the IEEE working group for IoT architecture frameworks (P2413 – Standard for an architectural framework for the Internet of Things), proposed framework for security from Cisco, architecture and security reference from Symantec.

B4 M2M system and device communication requirements

The principles and capabilities of system and device communication.

- System and device communication principles, including:
  - message delivery for devices in the sleep state where the device should awaken on request
  - delivery, including unicast (one to one), multicast (one to unique many), broadcast (one to many) and anycast (one to nearest) modes
  - message communication path selection and transmissions scheduling
  - communication failure notification and the mechanism for message confirmation
  - priority levels in messaging, where more important messages may take priority over others
  - logging, including the logging of important events or recording of faults and errors.

- System and device capabilities, including:
  - device and/or gateway integrity check to validate authenticity of firmware on the device
  - continuous connectivity, including the support for continuous connectivity from the system to the device on a regular and consistent basis
  - time stamps, including the secure, accurate and trusted stamping of data.
- The identification and network location of secure connected components to support the design of a scalable and efficient system and devices, including:
  - Internet Protocol (IP) address of individual and groups of objects
  - multicast address, e.g. using IPv6
  - E.164 addresses of connected objects, Mobile Station International Subscriber Directory Number (MSISDN).

B5 Security of IoT systems and devices

The management of security protection methods in IoT systems and devices.

- Security threats to unmanned or unguarded systems and devices, including physical tampering, hacking or unauthorised monitoring.
- Remote management, including firmware updates to correct faults or recovery operations.
- Effects of malicious attacks, e.g. loss of data, loss of control of the device and damage caused by the device.
- Security protection methods, including use of device certificates at each end to authenticate communications, data should be encrypted to prevent interception, use of SSL certificates and use of code signing with digital certificates to secure software and firmware updates.

Learning aim C: Carry out the prototyping of an integrated Internet of Things system or device to solve a problem

C1 M2M integrated system or device operations

The development and application of integrated operations for M2M systems or devices, including:

- connectivity and normalisation of M2M operations, including the integration of different protocols and different data formats into one software interface, ensuring accurate data string and interaction with all devices
- device management ensures the connected devices are working properly, seamlessly running patches and updates for software running on the device
- database use with a scalable storage for device data, satisfying requirements for hybrid cloud-based databases, e.g. with data volume, variety, velocity and conformity to accuracy
- processing and action management brings data to life with rule-based event action triggers, enabling execution of smart actions based on a specific sensor, e.g. event processing
- visualisation enables humans to see patterns and observe trends from visualisation dashboards, where data is vividly portrayed through graphical 2D and 3D models.

C2 Programming techniques and constructs

Programming techniques and constructs of hardware and software, including:

- use of a software development environment, e.g. software operation, connecting to off-the-shelf hardware, software development kits (for graphical and non-graphical computer programming), application programming interfaces, creating and managing program files, syntax/error checking, simulation (where applicable), compiling, downloading and live testing, monitoring and/or debugging
- off-the-shelf hardware device set-up and program initiation, e.g. introductory comments, pin modes, declarations, and code organisation and structure
- visual and non-visual programming constructs, including:
  - input and/or output, e.g. digital (bit and port level read/write), analogue (read/write and resolution), calibration, communication (serial and I2C)
  - program flow and control, including:
    - subroutines and functions: naming, declaring, call and return
    - control structure sequence selection iteration: if, else, switch, case, for, do, while, until and end
    - delays and timing
    - interrupts
  - logic and arithmetic, including:
    - variables, e.g. data types (Boolean, character, integer, word, float, string), declaration, conversion and manipulation
    - arrays (1D)
    - comparative operators, e.g. equal, not equal, less than, more than
    - Boolean operators, e.g. AND, OR, NOT
    - logic using input condition, e.g. digital and analogue
    - arithmetic operations, e.g. adding, subtracting, multiplication, division, increment, decrement, random.

C3 IoT analytics

The use of IoT data, including:

- extrapolation and prediction, e.g. the use of real-time data to analyse and predict weather patterns, the efficiency of a manufacturing process or the prediction of steps and calories from a fitness tracker
- metering and billing, e.g. the use of utility data such as water, gas and electricity to predict customer bills or suggest home improvements to save cost and reduce carbon
- activation of actuators, e.g. the lowering of a central heating system's temperature to cater for the rise in indoor and outdoor temperature.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Examine systems and services that form part of the Internet of Things		
A.P1 Describe the purpose and application of IoT systems and/or services from different sectors. **A.P2** Explain the principles and characteristics of IoT systems and/or services from different sectors.	**A.M1** Compare the purpose, applications, principles and characteristics of IoT systems and/or services from different sectors.	**A.D1** Evaluate the purpose, applications, principles and characteristics of IoT systems and/or services from different sectors.
Learning aim B: Develop a design for an Internet of Things system or device to solve a problem		
B.P3 Produce an IoT system or device design to solve a problem, including the architecture, standards, communication requirements and security. **B.P4** Review the IoT system or device design with others to identify and inform improvements.	**B.M2** Justify design decisions, showing how the system or device design will result in an effective IoT system or service solution.	**BC.D2** Evaluate an optimised IoT system or device design to solve a problem against the client's requirements and using feedback from others. **BC.D3** Optimise the prototype IoT system or device to solve a problem as intended and that meets the client's requirements, demonstrating individual responsibility and effective self-management.
Learning aim C: Carry out the prototyping of an integrated Internet of Things system or device to solve a problem		
C.P5 Develop a prototype IoT system or device with partial functionality to solve a problem. **C.P6** Review the extent to which the IoT system or device meets the client's requirements.	**C.M3** Develop a functional prototype IoT system or device to solve a problem as intended and that meets the client's requirements.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to a range of free and commercially available tools, software and off-the-shelf hardware, as well as case studies of existing IoT systems and/or devices. Resources may include:

- ThingSpeak™ – an IoT platform (thingspeak.com)
- Cisco® Packet Tracer v7.0 containing an IoT simulation tool
- off-the-shelf hardware, e.g. BBC® micro:bit, Genuino™/Arduino®, Netduino™ or Raspberry Pi™
- a range of sensors and actuators purchasable from nationwide components suppliers, e.g. Premier Farnell, Maplin™ or RS Components®
- IBM Bluemix®
- Freedomotic – an open IoT framework
- Node-RED™ – a visual tool for wiring the IoT (can be deployed to IBM Bluemix or locally) (nodered.org)
- Microsoft® Touch Develop development environment
- programming languages, e.g. Python™, Touch Develop, Java® and/or C++.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate the purpose and applications of IoT systems and/or services from at least two sectors. They will demonstrate knowledge and understanding of the principles and characteristics, both general and technical, of IoT systems from a range of different sectors and make comparisons between them. The evaluation will cover benefits and risks of each system and/or service and will make a supported judgement, showing the relationship to the context. For example, they will evaluate the relative benefits and risks of using an IoT heart rate monitor for the patient and the professional practitioners treating the patient.

Overall, the evidence, such as a report, will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will compare the purpose and applications of at least four IoT devices from at least two different sectors. They will compare the principles and characteristics, both technical and general, of each IoT system. For example, they will compare the use of wearable devices in the health and fitness sector and how they use continuous monitoring and real-time data.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will describe the purpose and applications of at least four different IoT systems and/or services from at least two different sectors. They will explain the principles and characteristics of the IoT systems and/or services and how they have been used. For example, an IoT heart rate monitor will transmit data via a close-range communication method to the user via a handheld device.

Overall, the evidence will be well structured with some use of appropriate technical language, although there may be some inaccuracies with terms used and it may be basic in parts. Some parts of the evidence may be considered in greater depth than others.

Learning aims B and C

For Distinction standard, learners will evaluate the IoT system or device, using feedback and comparison against the client's requirements, to produce an optimised design for the system. For example, a speed monitoring system could be optimised by using feedback that the distance between sensors was too great, so decreasing the distance between sensors could give more accurate readings and speed calculations. Learners will include a comprehensive range of risks and benefits of their design. They will include off-the-shelf hardware components and the standards, communications requirements and control diagrams, such as flow charts, of the design while taking security, local legal and sustainability characteristics into consideration.

They will develop their IoT system or device using off-the-shelf hardware components and suitable programming techniques and constructs. Their system or device will be functioning and efficient, and will meet the client's requirements. They will reflect on their own performance during the design and development of an IoT system or device and the evidence will demonstrate their effectiveness in self-management and individual responsibility. For example, the speed monitoring system could be optimised by reducing the sensitivity of the pressure sensors so they're triggered only by forces exerted through typical travelling vehicles, reducing the number of false recordings from pedestrian or cyclist travel.

Overall, the evidence will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, and consistent reference of information sources.

For Merit standard, learners will design an IoT system or device, justifying their design decisions and demonstrating how the design will result in an effective IoT solution. For example, for the design of a speed monitoring system, learners may justify the use of pressure sensors rather than infrared sensors because they can calculate the speed of a moving vehicle more accurately and reliably than infrared sensors in all weather conditions.

Learners will develop their IoT system or device and demonstrate through testing that it is functional and meets the client's requirements. For example, they may move a vehicle across two sensors at a known test speed and verify that the calculated IoT system speed matches the actual travel speed.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will design a system or device, ensuring that it adheres to the principles and characteristics of IoT, and that standards, communication methods and security issues are considered. They will annotate their designs using feedback from others to identify improvements that could be made during the development stage. For example, the design for a speed monitoring system will include two pressure sensors to detect moving traffic between them, which may have been moved closer together following feedback from others that would make the solution more practical.

Learners will develop a prototype using off-the-shelf hardware and suitable programming languages, such as Python, Touch Develop, Java and C++. Their prototype IoT device will have partial functionality to solve the intended problem and meet their initial requirements and designs. For example, the system may record the times that the pressure sensors were triggered but not be able to calculate the speed at which the vehicle was travelling. They will review the implementation and describe to what extent it meets the client's requirements.

Overall, the evidence will be well structured with some use of appropriate technical language (including definitions), although there may be some inaccuracies with terms used. The design may be basic in parts and some parts of the evidence may be considered in greater depth than others.

Links to other units

This unit links to:

- Unit 4: Programming
- Unit 6: Website Development
- Unit 7: Mobile Apps Development
- Unit 8: Computer Games Development
- Unit 9: IT Project Management
- Unit 11: Cyber Security and Incident Management
- Unit 13: Software Testing
- Unit 14: Customising and Integrating Applications
- Unit 15: Cloud Storage and Collaboration Tools.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to develop the Internet of Things system or device
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 19: Enterprise in IT

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners develop the skills and attributes needed for developing an IT product or service and use lean methods or a traditional business plan for starting up an enterprise.

Unit introduction

Entrepreneurial ideas in IT are plentiful, whether it is to design and develop new software or to provide IT support. IT businesses built on entrepreneurial ideas can create wealth for their owners and the nation, generate new employment opportunities, as well as provide customers with value-added products and services. WhatsApp®, Airbnb®, Impression, and Wizzed Media are examples of software, peer-to-peer services, digital marketing and websites, and mobile application start-ups that were once entrepreneurial ideas that successfully tapped into markets with a high demand and grew into thriving IT enterprises.

You will learn about enterprise by looking at the characteristics of entrepreneurs, the techniques they use and how these contribute to setting up and running an enterprise. Entrepreneurs have to drive through their ideas as there will be resources they need to gain and barriers to success they need to overcome, something that all entrepreneurs are accustomed to dealing with. You will examine whether you have the entrepreneurial skills to start up an IT enterprise. Once you have identified a potential IT product or service, you will investigate whether customers want it and what features they do and don't like. You will do this by carrying out market research and creating a marketing plan to drive sales and generate the cash needed by an enterprise to survive. Start-up enterprises also need smart, lean plans as entrepreneurs have to focus primarily on product and service development. However, both you and your stakeholders have to be convinced of the realism and viability of your entrepreneurial idea so you will learn how to produce and present a start-up plan for your IT enterprise.

The research, planning and communication skills you gain in this unit will prepare you for entry to higher education to study a range of degrees. The employability and entrepreneurial skills will also be useful when entering an IT apprenticeship or the workplace, or when setting up an enterprise.

Learning aims

In this unit you will:

A Explore the nature of enterprise and entrepreneurship in an IT context

B Develop a marketing plan for an IT product or service based on market research

C Present a plan for a start-up IT enterprise using lean or traditional business principles.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the nature of enterprise and entrepreneurship in an IT context	**A1** Entrepreneurship and enterprise principles and characteristics **A2** Skills audit and teamwork	A video, such as on YouTube™, on a successful enterprise and its entrepreneur that considers how the entrepreneur succeeded in building an enterprise that supplied products or services that customers wanted. A skills self-audit that identifies both entrepreneurial and IT skills, abilities and that considers teamwork.
B Develop a marketing plan for an IT product or service based on market research	**B1** Select a product or service idea to market for an IT enterprise **B2** Research the market opportunities for an IT product or service **B3** Marketing planning for an IT product or service	A marketing plan with supporting research identifying the approaches to be used when launching an IT product or service to the market. The market components of a Business Model Canvas or a Lean Canvas could be used, or alternatively a more traditional marketing plan template could be used.
C Present a plan for a start-up IT enterprise using lean or traditional business principles	**C1** Lean business planning **C2** Traditional business planning **C3** Create and present a start-up plan for an IT enterprise	Presentation of a plan for a start-up enterprise that suggests why the enterprise will become established and viable. The product components of a Business Model Canvas or a Lean Canvas could be used, or alternatively a more traditional business plan template could be used.

Content

Learning aim A: Explore the nature of enterprise and entrepreneurship in an IT context

A1 Entrepreneurship and enterprise principles and characteristics

The principles and characteristics of entrepreneurship.

- Enterprise is the process of using creativity and innovation to meet customers' needs and aspirations.
- Enterprise involves:
  - identifying gaps in the market to sell products and services and so create markets, grow markets, increase market share and become market leaders
  - creating products and services and selling them into an identified market.
- Enterprise skills and capabilities that are required to establish and drive an enterprise forward, including:
  - expertise: entrepreneurial and technical
  - enthusing and inspiring others
  - motivating teams and co-workers
  - commitment to work
  - attitude to risk, e.g. risk averse and risk taker.
- Factors that make enterprises successful, including:
  - good entrepreneurial and IT skills
  - teamwork
  - well-thought-through plans using lean or traditional business principles
  - competitive advantage, e.g. enterprise scale, unique selling point (USP) and lack of competition
  - access to finance for start-up and growth, e.g. own resources, bank loans, crowd funding, venture capital
  - positive perception that is communicated by word of mouth, social media, broadcast media and print media
  - product champions who promote the internal development and external promotion of a product or service
  - rapid market penetration and sales growth
  - effective customer service.
- Attributes of the entrepreneur typically include many of the following characteristics: creativity, confidence, positivity, passion, motivation, initiative, self-belief, discipline, drive, adaptability and flexibility, intuitiveness, imagination, desire to succeed and grow, vision, capacity to inspire, focus.
- Enterprise planning:
  - lean business models, e.g. the Business Model Canvas and the Lean Canvas, both of which identify how an enterprise will achieve its objectives, including:
    - strategy identifying short-, medium- and long-term objectives
    - identification of product or service characteristics
    - enterprise infrastructure
    - pricing structures and revenue streams

  - traditional business plans that provide a full description of the proposed enterprise and are particularly designed to pitch the enterprise to potential stakeholders identifying:
    - product or service to be supplied
    - legal structure and operation
    - capacity requirements and resources required, e.g. finance, human, physical, intellectual property
    - competitive environment and competitor analysis.
- New technologies and techniques for IT enterprises, e.g. additive manufacturing (3D printing), lean start-up, cloud-based working, integrated business systems, open sourcing.

A2 Skills audit and teamwork

The personal and teamwork skills audit process.

- Identification of entrepreneurial, enterprise and IT skills, e.g. programming, digital graphics and technical support that may be needed to become an IT entrepreneur.
- Personal entrepreneurial attributes.
- Recognising skills gaps and how to overcome them, e.g. the need to build a team of individuals with complementary expertise and skills, outsourcing, training.
- Teamwork to ensure enterprises can meet their objectives, including:
  - building teams with complementary skills
  - identifying the purpose of teams
  - motivating teams
  - managing teams
  - reviewing teams' performances.
- Collaborative working to foster teamwork, including:
  - online cooperation to:
    - test and brainstorm ideas
    - collect research on an idea or subject
    - assess own understanding of an idea or subject
    - share information with an audience
  - mentoring schemes and networking events.

Learning aim B: Develop a marketing plan for an IT product or service based on market research

B1 Select a product or service idea to market for an IT enterprise

The identification, creation and the skill required for the IT product or service.

- Identify an IT product or service to create an enterprise. Criteria to evaluate your ideas, e.g.:
  - product or service features and assessment of the benefits, including how well the proposed solution meets the customer's requirements, solves the problem(s) and whether it is unique
  - sustainability assessment depending on the product or service proposed, e.g. environmental impact, waste material, power usage, choice of material, recycling and reuse
  - security assessment, e.g. analysis of secure servers, software source control, 'penetration' testing and password protection

  - usability assessment, e.g. the appropriate design of user interfaces ensuring smooth and consistent integration with any required systems
  - financial assessment, including assessing the viability of the idea, revenues, costs
  - potential size of the market
  - local legal assessment.
- Create IT product or service collateral with which to conduct market research, including:
  - design information, e.g. storyboard, flow chart, and infographics
  - prototype products or services, e.g. website, computer programs and computer devices and video evidence.
- Identify the skills required for marketing a selected IT product or service, e.g.:
  - product knowledge
  - knowledge of the market
  - understanding customer requirements and needs
  - promotional methods.

B2 Research the market opportunities for an IT product or service

The factors that affect the market for an IT product or service.

- Qualitative and quantitative factors that affect the market for an IT product or service:
  - target market
  - customer requirements and needs
  - gaps in the market and the potential demand opportunities for a product or service
  - current market trends
  - competitor analysis
  - economic climate
  - business risks.
- Conducting market research on a prototype or design for an entrepreneurial IT product or service:
  - planning research, including:
    - defining the purpose of the research and setting objectives
    - planning data to be collected, including primary and secondary
    - methods of collection
  - carrying out research, including:
    - sample size
    - sample method
    - questionnaires
    - surveys
  - interpreting research findings, including:
    - statistical procedures, e.g. central tendency, range, time series, scatter diagrams, trends, use of spreadsheets for analysis
    - presentation of findings, e.g. reports, tabulations, graphics
    - conclusions
    - recommendations for action
    - limitations of research, e.g. reliability of sample, accuracy, bias, subjectivity.

B3 Marketing planning for an IT product or service

The requirements of the creation and monitoring of the marketing plan.

- Marketing plans identify marketing strategy and objectives, how they will be achieved and how they link to the enterprise's overarching objectives.
- Components of a marketing plan:
  - product or service characteristics, including USP or unique value proposition (UVP), links to target market and market segment
  - pricing methods
  - promotion, including the promotional mix, links to target market and market segmentation, the use of technology in promoting the business and its products, e.g. websites, social media, online reviews and apps
  - channels to market and distribution methods
  - interrelationships between the components of the marketing plan.
- Market testing to establish what products and services will work before committing additional resources. Techniques include:
  - limited or small-scale roll-out
  - beta versions or prototypes for products and services to test them
  - free products in exchange for feedback
  - seeking opinions and views about a product or service via collaborative platforms
  - market simulations.
- Monitoring the effectiveness of marketing plans, e.g.:
  - volume of sales and rate of growth of sales
  - size of market share and growth of market share
  - customer perceptions of product quality
  - sales revenue compared to marketing costs.

Learning aim C: Present a plan for a start-up IT enterprise using lean or traditional business principles

C1 Lean business planning

Lean business plans that focus on the entrepreneur. A lean business plan allows start-ups to develop products or services iteratively to meet the needs of customers, reduce the market risks, reduce the development time and avoid waste and failure.

- Lean business start-up techniques include:
  - creating a minimum viable product
  - continuous deployment of software
  - split testing of products and services
  - actionable metrics that identify the main drivers for an enterprise business
  - pivoting by changing the direction in response to data from actionable metrics
  - innovation accounting by using a feedback loop that defines, measures and communicates the progress of an enterprise
  - product development that uses build–measure–learn to shorten the product development time.
- The components of a lean business plan:
  - product oriented, including UVP, problems, solutions, key metrics, milestones and cost structures
  - market oriented, including competitive advantage and barriers to entry, customer segments, channels to market and revenue streams.

C2 Traditional business planning

The components and requirements of a traditional business plan:

- executive summary, including vision, purpose, summary of proposition, outline of rewards
- legal structure and operation, e.g. sole trader, business partnership, limited partnership, limited liability partnership, limited company
- finance, including requirements, potential sources of finance
- summary of market(s) and competition, including local, national and international business environment, market research, competitor analysis
- measures of success, including financial and non-financial key performance measures and SMART (Specific, Measurable, Achievable, Realistic, Time-constrained) targets:
  - financial, e.g. market share, sales, turnover, profit and profit margins
  - non-financial, e.g. analysis of performance against business vision, mission, aims and objectives, customer satisfaction, product reliability
- appendices covering any other evidence to support business plan, e.g. personal profile of the owner, decision making and reporting structures in the business, advisers, prototype of the product or service.

C3 Create and present a start-up plan for an IT enterprise

The concepts and processes of the start-up plan for an IT enterprise.

- Produce a plan for a start-up IT enterprise using either a lean methodology and planning technique, e.g. a lean canvas, or a traditional business plan.
- Create a presentation for the start-up international IT enterprise for an external audience.
- Present the plan to an external audience.
- Obtain feedback from the audience.
- Reflect on the feedback and review the plan in response to the feedback.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Explore the nature of enterprise and entrepreneurship in an IT context		**A.D1** Evaluate, using examples, the principles and characteristics that lead to successful enterprises and your own skills, justifying how any skills gaps could be effectively overcome.
A.P1 Explain, using examples, the principles and characteristics that lead to successful enterprises. **A.P2** Perform an audit of own entrepreneurial and IT skills, describing any skills gaps.	**A.M1** Discuss, using examples, the principles and characteristics that lead to successful enterprises. **A.M2** Perform a realistic audit of own skills, explaining how any skills gaps could be overcome.	
Learning aim B: Develop a marketing plan for an IT product or service based on market research		**B.D2** Evaluate a comprehensive and well-reasoned marketing plan for an IT product or service, based on effective research and an appropriate idea selection process.
B.P3 Select an idea using a range of criteria for an IT product or service. **B.P4** Research, with some inconsistencies, the potential market for an IT product or service. **B.P5** Create a marketing plan, with some inconsistencies, for an IT product or service.	**B.M3** Develop a reasoned marketing plan for an IT product or service, using appropriate research and an appropriate idea selection process.	
Learning aim C: Present a plan for a start-up IT enterprise using lean or traditional business principles		**C.D3** Present clearly and concisely a well-reasoned and effective plan to start up an IT enterprise.
C.P6 Produce a basic plan to start up an IT enterprise. **C.P7** Present, with some lack of clarity, a plan to start up an IT enterprise.	**C.M4** Present clearly a reasoned plan to start up an IT enterprise.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.M2, A.D1)

Learning aim: B (B.P3, B.P4, B.P5, B.M3, B.D2)

Learning aim: C (C.P6, C.P7, C.M4, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to information about IT enterprises and associated activities, particularly in respect of new and small enterprises. It is expected that learners within a cohort will individually select and research the entrepreneurship in new and developing enterprises.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate how the principles and characteristics of at least two IT enterprises have contributed towards their success. Learners will draw on varied information that leads to a supported judgement, showing the relationship to the context. For example, the founders of Apple used their chip design, computer building and sales skills to start a business. They spotted a gap in the market and took a risk, selling their personal possessions to fund a start-up enterprise because they judged that customers would buy small, cheap computers for home use.

Learners will evaluate their own skills by performing a realistic skills audit. They will provide a supported judgement about their skills and expertise and state the relevance and significance of their strengths and weaknesses to starting an enterprise. For example, learners may demonstrate their IT expertise with a piece of software they have written but recognise that they would need to develop some marketing skills to start a successful enterprise. They will justify how effective teamwork could overcome any skills gaps. For example, the lack of marketing skills could be overcome by developing a team with the complementary marketing expertise, rather than diverting their own effort away from developing an IT product or service.

Overall, the evidence, such as a report, will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language throughout, and be fluently written (i.e. consistent use of correct grammar and spelling) and/or spoken.

For Merit standard, learners will discuss how the principles and characteristics of enterprises have contributed to their success. For example, the founders of Apple recognised that the IT skills used to build computers needed to be complemented by design skills to produce a product that would be attractive to customers. From its earliest days, Apple has driven its success and become a market leader by ensuring that its design team prioritises the creation of products that are visually appealing and some of the easiest to use.

Learners will perform a realistic audit of their own skills. For example, they will identify what abilities they have in respect of IT and business but recognise how these might need developing, so communication and presentation skills might need improving to persuade and convince others about the prospects for a successful IT enterprise.

Using their audit, they will explain how they could overcome any skills gaps through teamwork. For example, they could discuss how teamwork involves working collaboratively with others and/or building a team to extend the enterprise's skill set.

Overall, the evidence will be logically structured, use appropriate business and IT terminology accurately and be clearly expressed so as to be understood by the target audience.

For Pass standard, learners will explain the principles and characteristics that lead to successful enterprises and how customer needs are being met. For example, Apple identified a market for small, competitively priced, user-friendly computers for home users that was likely to be sufficiently enduring to provide a sound basis for an enterprise.

Learners will produce an audit of their own entrepreneurial and IT skills to assess their suitability to set up and/or manage a small IT enterprise. They will describe any skills gaps they may have but will not justify how they would overcome them. For example, they may have strong entrepreneurial skills but lack the computer programming skills and experience needed to develop a software product. The audit may also fail to identify some skills that may be relevant. For example, speaking a foreign language and being able to drive a car might seem irrelevant to IT and therefore be overlooked but they may be important for a start-up enterprise.

Overall, the evidence will be logically structured but it may be basic in parts. It may contain minor technical inaccuracies relating to the use of business and IT terminology.

Learning aim B

For Distinction standard, learners will concisely evaluate their comprehensive and well-reasoned marketing plan for an IT product or service. For example, they will provide a supported judgement using information from a variety of sources and clear criteria about the completeness of the plan and how the market research shapes the proposals in the plan. Links between the components of the plan will be clear and reasoned so if, for instance, the product or service is targeted at the millennial generation then the promotion techniques should be those that best access that market segment. The market research underpinning the plan will have a clear rationale, follow market research principles and have a reasoned interpretation of the findings and their value to marketing planning. The selection of a product or service will be one whose viability is supported by the results of the market research.

Overall, the evidence, such as a report, will be easy to read and understand by a third party. It will be logically structured, use appropriate technical language throughout, and be fluently written, using a high standard of written language, i.e. consistent use of correct grammar and spelling, where appropriate. Consistent reference of information sources will also be appropriate and consistent.

For Merit standard, learners will develop a reasoned marketing plan for an IT product or service. The justification for the choice of product or service will include evidence from the use of appropriate selection criteria service and from conducting appropriate market research. For example, there needs to be a rationale for both the selection of the product or service and for the design of the market research. There must be mutual consistency between the choice of product and the results of the market research and consistency between the components of the marketing plan.

Overall, the marketing plan and supporting information need to be logically structured, use appropriate business and IT terminology accurately and be clearly expressed so as to be understood by the target audience.

For Pass standard, learners will select an idea for an IT product or service using a range of criteria. For example, a digital marketing agency may be assessed using the following criteria: product functionality, usability and security. However, one or two key criteria may have been missed.

Learners will complete research on the product or service idea, although the research may be inconsistent. For example, learners may have focused their research on the product features and functions and may not have considered price.

Learners will create a marketing plan with some inconsistencies, where some components of the plan may need to be more fully developed and/or linked more clearly and logically. For example, premium pricing for a product or service targeted at young people such as a simple word-based game would not be logical.

Overall, the market investigation, marketing plan and any supporting information need to be logically structured but it may be basic in parts. It may contain minor technical inaccuracies relating to the use of business and IT terminology.

Learning aim C

For Distinction standard, learners will present clearly and concisely a well-reasoned and effective plan to start up an IT enterprise. For example, a judgement should be made about the completeness of the plan using information from a variety of sources. There will be an assessment of how effectively the plan deals with the issues that have to be considered when starting up an enterprise, so the plan may need some flexibility and spare capacity built in to ensure the enterprise does not immediately fail through a lack of resilience. The presentation needs to be sharply focused and clearly expressed to gain the attention of interested parties such as those who might invest in the enterprise.

Overall, the evidence and presentation will be easy to comprehend by the target audience. They will be logically structured, use appropriate technical language fluently throughout and use a high standard of written language, i.e. consistent use of correct grammar and spelling, where appropriate. Reference to information sources will be appropriate and consistent.

For Merit standard, learners will present clearly a reasoned plan to start up an IT enterprise. For example, the rationale behind the start-up plan may be that the product or service is in a niche market where competition is limited or where the product or service is particularly innovative. The interrelationship between the plan components must be identified and be consistent.

Overall, the start-up plan and its presentation, plus any supporting information, need to be logically structured, use appropriate business and IT terminology accurately and be clearly expressed so as to be understood by the target audience.

For Pass standard, learners will produce a basic plan to start up an IT enterprise. For example, although each component of the plan may be complete, there will be a lack of detail about what is proposed and how it will be implemented.

Learners will present, with some lack of clarity, a plan to start up an IT enterprise. For example, the presentation may need to be more logically structured, more fluently expressed or need to make better use of supporting information.

Overall, the start-up plan, the presentation and the supporting information need to use standard formats and structures. There may be a lack of detail or inconsistencies and the plan and presentation may also contain minor technical inaccuracies relating to the use of business and IT terminology.

Links to other units

This unit links to:

- Unit 3: Using Social Media in Business
- Unit 20: Business Process Modelling Tools.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used to start-up an international IT enterprise
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 20: Business Process Modelling Tools

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners investigate business processes and their relationship to an organisation's aims and objectives. They will model a specific process and develop a plan to improve it.

Unit introduction

Most small, medium and large organisations use an interrelated series of processes which carry out functions, such as manufacturing an item, placing an order or hiring a new employee. Understanding these processes is important so that you can apply new technology to improve them. Business processes in any organisation need to support their business aims and objectives. For example, if an organisation's aim is to provide excellent customer service, then the processes that include customer interaction need to reflect this. As a business or systems analyst, you will work with organisations to analyse their processes so that you can inform how improvements could be made.

In this unit, you will investigate business aims and objectives, organisation models and departmental functions and processes and their interrelationships. You will select a specific business process to examine and produce a model of the way it operates. Finally, you will develop a plan to improve the process to better support the businesses aims and objectives.

This unit will give you the knowledge, skills and confidence to become a business or systems analyst in the field of business software development, either directly through employment or an apprenticeship scheme, or to support continuing studies in further and higher education.

Learning aims

In this unit you will:

A Investigate the processes that organisations use to support their activities

B Examine an organisation's business processes and activities to inform improvements

C Develop a plan to improve an organisation's business processes and activities.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the processes that organisations use to support their activities	**A1** Business aims and objectives **A2** Organisational models and department functions **A3** Types of business processes **A4** Drivers for change	A report, blog or presentation materials covering business aims and objectives, organisational models, department functions and reasons for change.
B Examine an organisation's business processes and activities to inform improvements	**B1** Investigation methods **B2** Analysis of a business process **B3** Business process modelling tools	Interview recordings, observation statements and documentation providing evidence of the investigations. Annotated diagrams of business processes. Records of discussions covering the analysis of the impact of business process changes. Annotated diagram of the improved business processes. Evidence of feedback (recording of discussions or written feedback). Recorded or written evaluations of the plan and the working practices.
C Develop a plan to improve an organisation's business processes and activities	**C1** Sources of innovation to improve business processes **C2** Business process redesign and improvement **C3** Change management **C4** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate the processes that organisations use to support their activities

A1 Business aims and objectives

The concepts of an organisation's business aims and objectives.

- How an organisation's aims and objectives relate to the processes that implement its activities.
- The purpose of mission statements and business goals.
- Importance of service level, customer satisfaction, quality and pricing to an organisation.

A2 Organisational models and department functions

The functions of organisational models and department functions.

- Types of organisation or business, legal structure:
  - sole trader
  - partnership
  - limited company
  - charity
  - private and public organisations.
- Industry sectors:
  - primary
  - secondary
  - tertiary.
- Department functional areas, such as:
  - operations
  - finance
  - customer service
  - sales and marketing
  - research and development
  - human resources.
- How the functional areas interlink in an organisation to support business aims and objectives.

A3 Types of business processes

The function of business processes.

- Management processes, such as strategic planning.
- Operational processes, such as:
  - purchasing
  - manufacturing
  - sales
  - marketing.
- Supporting processes, such as:
  - accounts
  - recruitment
  - technical support.

A4 Drivers for change

The reasons why business processes need to change:

- improve productivity
- meet demand for shorter process timescales
- increase competitiveness
- reduce costs
- take advantage of changes in technology
- respond to political, economic and social pressures, and local legal and regulatory changes.

Learning aim B: Examine an organisation's business processes and activities to inform improvements

B1 Investigation methods

The features of investigation methods used to understand a business process.

- Methods used to understand a business process:
  - observation of the process in action
  - inspecting relevant documentation such as procedure manuals
  - interviews with staff who implement or manage the process.
- Methods of recording the details of the process such as video or audio recording, note taking.

B2 Analysis of a business process

The concepts and analysis of the business process.

- The purpose of the business process and nature of the process, e.g. paper-based, physical (such as taking an item of stock and despatching it), IT-based.
- The inputs and outputs of the process, process attributes.
- Decomposition into subprocesses.
- The individual activities of the process/subprocess, rules (internal or external) that apply to the activities, how decisions are made, e.g. if payment is overdue, send reminder letter and block account.

B3 Business process modelling tools

The tools used to model business processes:

- flow diagrams
- decision tables
- use case diagrams
- activity diagrams.

Learning aim C: Develop a plan to improve an organisation's business processes and activities

C1 Sources of innovation to improve business processes

The process of innovation and idea creation.

- Sources of innovation to support process improvement:
  - research and development
  - customer and employee suggestions
  - collaboration
  - market research.
- Problem solving and idea creation methods:
  - brainstorming
  - cause and effect diagrams.

C2 Business process redesign and improvement

The concepts of business process reengineering and technologies used to support process change.

- Business process reengineering (BPR) and its use to redesign existing business processes:
  - alignment of processes to business objectives
  - use of technology to radically change how a process is done
  - analysis of organisational mission and goals, identification of customer needs
  - identify the process to be reengineered
  - analyse the current 'as-is' state of the process
  - design the 'to-be' process
  - implement and test the redesigned process.
- Use of technologies which can support process change such as:
  - shared databases
  - expert systems
  - technology to support remote working
  - automatic identification and tracking, e.g. radio-frequency identification (RFID) tags, Global Positioning System (GPS) tracking.

C3 Change management

The process of change management on the business model.

- The effects of change on an organisation, including how the redeveloped process will impact the existing organisation in terms of:
  - staffing – staff number, skill requirements, current staff skills and need for development and training in the new way of working
  - resources – suitability of premises and their location factory/storage/office, layout, equipment
  - customers – the way they do business with the organisation.
- Process change risks:
  - potential benefits may not be realised
  - disruption may cause delays and impact customers
  - employees may be unhappy with changes
  - technology may prove too complex or fail to deliver the expected benefits
  - changes may cost more to implement than originally budgeted.

- Risk mitigating methods:
  - project planning and management, contingency plans, regular reviews, tracking of the change process
  - prototyping or piloting the changes
  - testing of new systems and processes
  - regular and timely communication with staff and other stakeholders (suppliers, customers) about the changes, collecting and responding to feedback
  - timely training of staff on new systems and processes.

C4 Skills, knowledge and behaviours

The skills, knowledge and behaviours required when reviewing business processes.

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others.
- Demonstrate behaviour and its impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use), verbal communication requirements (one-to-one and group informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectations, resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Investigate the processes that organisations use to support their activities		
A.P1 Explain how different types of business processes are used to support an organisation's requirements. **A.P2** Explain how technologies are used to support business processes and their potential impact.	**A.M1** Analyse the impact of using business processes and technologies to support an organisation's requirements.	**A.D1** Evaluate the effectiveness of technologies used to improve business processes which support an organisation's requirements.
Learning aim B: Examine an organisation's business processes and activities to inform improvements		
B.P3 Produce a clear model for an existing business process which supports an organisation's requirements. **B.P4** Assess an existing business process used to support an organisation's requirements and identify potential improvements.	**B.M2** Analyse the ways in which an existing business process supports an organisation's requirements.	**BC.D2** Evaluate the plan against the model, showing the effectiveness of the new business process and activities.
Learning aim C: Develop a plan to improve an international organisation's business processes and activities		
C.P5 Produce a plan for improving a business process with technology and change management that supports an organisation's requirements. **C.P6** Assess how feedback has been used to refine the plan to improve a business process and activities to support an organisation's requirements.	**C.M3** Justify decisions made in a plan to improve a business process.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, it would useful if learners had access to local employers who could help them in their investigation and planning of the re-engineering of business processes.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will provide a clear and balanced evaluation of the effectiveness of technology in improving business processes, which is clearly linked to organisational requirements and is supported by real life examples. Learners must articulate their arguments fluently and views concisely, providing an evaluation which makes reasoned, valid judgements. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent business and technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For Merit standard, learners will present a reasoned and well-explained analysis of the impact of business processes and technology, clearly relating this to business requirements. The evidence must provide a balanced discussion supported by clear examples from real life businesses. The evidence must be technically accurate and demonstrate good-quality written or oral communication.

For a Pass standard, learners will provide an explanation of the different types of business processes, as listed in the unit content, how they support typical organisation requirements and how technology is used to support those processes. The evidence may have some inaccuracies and may include some limited examples from real businesses.

Learning aims B and C

For Distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and processes applied throughout the investigation, modelling and planning impacted the effectiveness of their plan to improve a business process. Learners must provide a reasoned and realistic review of their plan, identifying both the positive and negative aspects. They must clearly explain how the plan to change the business process will support the business requirements, giving specific, well thought out and realistic examples. Learners need to show clearly how their planned changes to the process provide specific measurable improvements over the process they modelled. They must also explain how the potential risks of the changes can be minimised by the application of change management processes.

Learners must articulate their arguments and views concisely and professionally, and evaluate concepts, ideas and actions thoroughly to reach reasoned and valid conclusions. They must demonstrate individual responsibility, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials, and effective self-management when assessing the suitability of the plan for a new business process and associated activities.

Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For Merit standard, learners will give a clear, accurate and well-reasoned analysis of how well the existing business process supports the organisation's stated requirements. They also need to provide a well-explained justification of each aspect of their plan to improve the business process, referring to both their own ideas and the feedback they obtained on the plan. They must explain why they included each aspect of their plan, the purpose of each aspect and how it helps to ensure the success of the implementation of the improved business process.

For Pass standard, learners will provide evidence that they have used appropriate methods to collect information on the specific process they are investigating, such as interview recordings, observation reports or copies of documents. They must provide detailed, annotated diagrams that model the process, showing its subprocesses and activities and interrelationships with other processes. They must also provide a clear assessment of the process, identifying strong and weak aspects and identifying realistic potential improvements.

Learners must develop a well-thought-out and realistic plan to modify the specific process they have been investigating. The plan will include use of technology and must consist of annotated diagrams, clearly showing how the reengineered process will work, including subprocesses, activities and interrelationships. Learners also need to explain the methods they will use to manage the change to the process. They must obtain feedback on the plan, preferably from someone with business experience who can provide helpful advice on the suitability of the plan. This feedback will be used to refine the plan.

Links to other units

This unit links to:

- Unit 2: Creating Systems to Manage Information
- Unit 5: Data Modelling
- Unit 14: Customising and Integrating Applications
- Unit 19: Enterprise in IT.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills including:

- analytical and decision-making skills
- formal written communication
- selection of appropriate IT tools and systems used in business processes
- self-management and planning skills
- ability to work in a legal, moral and ethical manner.

Unit 21: Introduction to Artificial Intelligence (AI)

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners will explore the applications of artificial intelligence (AI) and how it can be used to solve complex problems.

Unit introduction

Artificial intelligence (AI) has been an area of information technology that has been studied by academics since the early days of computers. It is only in recent years however, due to the increased availability of digital systems, increases in computing power and the vast amount of data, that AI has seen wider scale adoption. AI of varying types is now used in many of the different business and personal systems we interact with on a day-to-day basis. Whether it be a digital voice assistant such as Siri, Cortana and Alexa, or personalised recommendations in an e-commerce site, or even image filters on a smartphone's camera, AI has changed the way in which computers can be utilised.

In this unit, you will explore how AI is used in different industries to solve problems, inform decisions and improve performance. You will explore the import role data has in AI systems, how different algorithms are used to draw meaningful information from data, and how in turn these systems can 'learn'. You will collect and prepare data, and apply computing resources, to develop an AI solution in response to an identified problem.

The analytical and problem-solving skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment.

Learning aims

In this unit, you will:

A Investigate uses and applications of AI

B Plan and prepare an AI solution to meet identified needs

C Develop an AI solution to meet identified needs.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate uses and applications of AI	**A1** Uses and applications of AI **A2** Implications of AI	A written report exploring how and why different industries utilise AI solutions, the benefits they can bring, and any associated risks and drawbacks.
B Plan and prepare an AI solution to meet identified needs	**B1** Data for AI **B2** Gathering and preparing data	A portfolio of evidence detailing the creation of an AI solution will include: • defining the objectives of the project/task • collection of data and preparation for appropriate data sets • coding an AI solution • testing and refining the solution • evaluation of the solution against objectives.
C Develop an AI solution to meet identified needs	**C1** AI models **C2** Tools for the development AI solutions	

Content

Learning aim A: Investigate uses and applications of AI

A1 Uses and applications of AI

The fundamental concepts of AI and its sub-disciplines and their use in different industries.

- The definition of AI and the differences between weak AI and strong AI.
- Types of AI including:
  - reactive machines
  - limited memory
  - theory of mind
  - self-awareness.
- Subsets of AI including:
  - machine learning
  - computer vision
  - deep learning
  - natural language processing
  - expert systems.
- The links between AI and other disciplines, e.g. computer science, mathematics, psychology, linguistics.
- Developments in AI including current possibilities with AI and theoretical goals of AI.
- The applications of AI, e.g. prediction/forecasting, anomaly detection, knowledge mining, conversational AI, targeted advertising, facial recognition.
- The uses of AI in different industries and sectors, e.g. retail and e-commerce, transportation and logistics, financial services, public services.

A2 Implications of AI

The wider considerations for individuals and organisations in relation to the adoption and use of AI systems.

- Ethical and legal considerations when utilising AI, including:
  - data security and privacy, e.g. GDPR in Europe
  - bias and discrimination, e.g. in education, justice
  - judgement in safety critical systems
  - social and economic impact
  - polarisation.
- The principles of explainable AI (XAI), and the importance of presenting AI systems in a transparent way.
- The need to follow a structured AI development process/AI pipeline, and how each stage impacts on an organisation and its stakeholders:
  - define project goals
  - data audit
  - research (solutions, algorithms and existing models)
  - design and build the model
  - deploy and use.

- Organisational factors to consider when utilising AI in an organisation:
  - business capacity
  - human capacity
  - technical capacity, e.g. security considerations, available infrastructure, potential upgrade requirements.
- The benefits of AI in different sectors.
- The risks and drawbacks of AI in different sectors.
- The importance of selecting the correct AI solution to meet operational needs and knowing when not to use AI or machine learning.

Learning aim B: Plan and prepare an AI solution to meet identified needs

B1 Data for AI

- The fundamental concepts of data and its use in AI.
- Different types of data and how this impacts its storage and use:
  - structured data
  - unstructured data
  - semi-structured data
  - time-series data.
- Sources of data including:
  - web/social media
  - point of sales and stick control systems
  - e-commerce systems
  - internet of things (IoT)
  - corporate data sources, e.g. databases, spreadsheets.
- Impact of the size of a data set on its storage and use.
- The use of big data in AI solutions.
- The 'Five Vs' of big data (volume, variability, velocity, veracity, value).
- The differences between qualitative and quantitative data and the uses of each.
- Data processing activities and their use in AI:
  - descriptive analytics
  - diagnostic analytics
  - extraction, transformation and load (ETL)
  - predictive analytics
  - prescriptive analytics
  - data visualisation.

B2 Gathering and preparing data

- The principles and processes of data collection and preparation to ensure high quality data for an AI solution.
- Selecting suitable data and data sources, including:
  - identifying objectives of the project or task
  - reviewing available data
  - identifying appropriateness and suitability of current available data
  - identifying shortfalls in current data in relation to the objectives.

- Gathering and preparing data for a project:
  - the concept of bias and how to reduce its impact on data sets
  - identifying and accessing suitable and reliable sources of data
  - preparing data ready for use, e.g. cleansing data, removing redundancy, combining/aggregating data sets, checking validity of data.
- Selecting and using appropriate data structures and formats, e.g. JSON, CSV, XML.
- Legislative, ethical and security considerations when gathering, preparing and using data for an AI project, including:
  - local current and relevant legislative issues
  - ethical issues, including individual and organisational rights and responsibilities, e.g. guaranteeing individual anonymity while maintaining the quality of data
  - ensuring security and privacy of personal and sensitive data
  - protecting data against damage or corruption.
- Selecting and preparing training, validation, and testing data sets for an AI project.

Learning aim C: Develop an AI solution to meet identified needs

C1 AI models

- The selection and application AI models to meet project requirements.
- Categorising the model required by input:
  - supervised learning (classification, regression)
  - unsupervised learning (clustering, dimensionality reduction).
- Categorising the model by required output:
  - number (regression)
  - class (classification)
  - a set of groups (clustering)
  - main features in complex data (dimensionality reduction).
- Application and use of models for **regression** problems including:
  - linear regression
  - logistic regression
  - ARIMA (autoregressive integrated moving average).
- Application and use of models for **classification** problems including:
  - SVM (support vector machines)
  - trees and forests
  - Bayesian methods.
- Application and use of models for **clustering** problems including
  - K-means
  - PCA (principal components analysis).
- Application and use of models for anomaly detection, e.g. K-nearest neighbour (KNN).
- The uses, benefits and drawbacks of neural networks.

C2 Tools for the development AI solutions

- Select and apply appropriate tools for the development of AI solutions.
- Application of explainable AI (XAI) and the use of visualisation and dashboarding tools to present results, processes outputs in a transparent and meaningful way.
- Computer programming and scripting languages for coding solutions, e.g. Python, Lisp, R, Java.
- Libraries and frameworks, e.g. TensorFlow, OpenNN, OpenCV, Weka, Apache Hadoop.
- Use of tools provided by integrated development environments and related code development tools, including:
  - code and syntax highlighting
  - code completion
  - interpreter/compiler
  - debugger
  - code management platform/repository (Git) integration.
- Cloud computing to provision scalable resources for data and processing, e.g. Azure AI, Amazon SageMaker, Google AI.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate uses and applications of AI</td><td rowspan="2">A.D1 Evaluate the impact of AI on different industries.</td></tr>
<tr><td>A.P1 Describe how the fundamental concepts of AI are used in industry to meet specific identified needs.
A.P2 Explain the associated benefits, risks and drawbacks of AI in different industries.</td><td>A.M1 Analyse the benefits, risks and drawbacks of AI and how they impact on different industries.</td></tr>
<tr><td colspan="2">Learning aim B: Plan and prepare an AI solution to meet identified needs</td><td rowspan="4">BC.D2 Evaluate the effectiveness of the AI solution.</td></tr>
<tr><td>B.P3 Define the objectives of an AI project.
B.P4 Gather and prepare appropriate data sets for an AI solution.</td><td>B.M2 Review and refine data sets to optimise the quality of an AI solution.</td></tr>
<tr><td colspan="2">Learning aim C: Develop an AI solution to meet identified needs</td></tr>
<tr><td>C.P5 Develop an AI solution using an appropriate programming language and computing tools.</td><td>C.M3 Test and refine the AI solution.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. Section 6 Internal assessment gives information on setting assignments and there is also further information on our website.

There is a maximum number of **two** summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim A: (A.P1, A.P2, A.M1, A.D1)

Learning aims B and C: (B.P3, B.P4, C.P5, B.M2, C.M3, BC.D2)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- sources of large data sets to train and test the AI solution
- industry standard software (such as IDEs), suitable programming languages and AI libraries
- cloud technologies, e.g. AWS SageMaker, Google AI.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will present an evaluation of AI in different industries. Learners will evaluate the use of different types of AI (e.g. machine learning, deep learning, computer vision) considering how they are applied in different contexts. The evaluation will look at ways that AI is applied to solve problems and meet specific objectives, drawing comparisons between the uses in different contexts. The evaluation should consider a range of benefits, risks and drawbacks of AI and ways that adopting AI solutions can impact on organisations. Learners will detail the business, human, technical, and ethical and legislative factors that can have an impact on the adoption and success of AI solutions, providing supported value judgements as to the impacts these things can have in specific cases.

Overall, the evidence will be logically structured and use correct technical terms with a high standard of written language, including the consistent use of correct grammar and spelling.

For Merit standard, learners will present an analysis of AI in different industries. Learners will consider the use of different types of AI (e.g. machine learning, deep learning, computer vision) exploring how they are applied in different contexts. The analysis will look at ways that AI is applied to solve problems and meet specific needs. The analysis should consider a range of benefits, risks and drawbacks of AI and ways that adopting AI solutions can impact on organisations. Learners will detail the business, human, technical, and ethical and legislative factors that can have an impact on the adoption and success of AI solutions.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will describe the use of AI in different industries. Learners will explore the fundamental concepts of AI (e.g. the use of different types of AI such as machine learning, deep learning, computer vision), exploring how they are applied in different industries. Learners will identify and explain ways that AI is applied to solve problems and meet specific needs. Learners should consider benefits, risks and drawbacks of AI and ways that adopting AI solutions can impact on organisations. Learners will detail the business, human, technical, and ethical and legislative factors that can have an impact on the adoption and success of AI solutions.

Overall, the evidence will be logically structured. It may be basic in parts, for example the range of AI subsets may not be extensive, and the risks, benefits and drawbacks may be unbalanced or generic. The evidence may contain minor inaccuracies or omissions.

Learning aims B and C

For Distinction standard, learners will evaluate their refined AI solution and related data sets. As part of the evaluation learners will make value judgements regarding how their choice and application of AI model (e.g. unsupervised learning vs. supervised learning, classification vs. regression) impacted on the success of their AI solution. Learners will evaluate how the data used impacted on the quality and reliability of the AI solution's outcomes. For example, they may consider the approach they took when gathering and preparing data (e.g. cleansing data, combining sources, potential bias) and how the choices they made during this process affected the quality of training, testing and using the AI solution. They will also consider how and why the data was refined to improve outcomes and refine hypotheses and/or objectives.

Learners will consider the choice of tools and evaluate how the tools used contributed to the outcomes of the project.

Learner' evaluations will make value judgements regarding the solution in comparison to the initial and, if relevant, refined objectives. The evaluation will be supported by specific comprehensive justifications that are supported by clear evidence from learner work.

For Merit standard learners will test and review their AI solution and related data sets. As part of the review learners will consider the quality, accuracy and reliability of the outcomes generated by the solution, and use these observations to refine the data sets, and AI approaches to improve the solution.

As part of this process learners should review their objectives and hypotheses and update these as required based on the outcomes of each iteration of the AI solution.

Learners will produce additional iterations of the solution and data sets, as they review and refine, which should be included in their portfolio of evidence. The evidence should be supported by accompanying documentation detailing the review and testing process they followed.

For Pass standard, learners will produce a set of objectives for the AI project they intend to implement. The objectives should provide a summary of the overall purpose of the project and a list of success criteria/functional requirements against which they review their AI solution and related data sets. The functional requirements will consist of metrics by which the solution can be measured, and a set of hypotheses that will be tested/explored.

Learners will select a suitable AI model and use this to produce an AI solution to meet the objectives they have devised. The solution will be functional but there may be some minor issues in terms of accuracy and/or performance. The solution will meet some of the listed objectives that they have listed.

Learners will provide a portfolio of evidence that demonstrates the gathering and preparation of data, and documents the implementation of the solution. They should also provide evidence of a working solution and how the AI solution meets the objectives. How this is presented will vary depending on the AI project chosen.

Links to other units

This unit links to:

- Unit 4: Programming
- Unit10: Big Data and Business Analytics
- Unit 18: The Internet of Things
- Unit 22: Introduction to Robotics and Automation
- Unit 23: Emerging Trends and Technologies.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- problem solving
- data handling.

Unit 22: Introduction to Robotics and Automation

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners will explore the applications of robotics and automation and how they can be applied to form complex systems to solve problems.

Unit introduction

Robotics and automation have long been a focus of computing professionals. The desire to take mundane or dangerous tasks and assign them to a machine has driven this field of computing for many years and continues to have an impact on many parts of our society. When we think about robotics, we often picture large-scale manufacturing, such as car assembly lines. While manufacturing is still a key area of robotics and automation, recent years have seen the development of smaller scale robotics such as automated home appliances, for example Roomba vacuum cleaner, lawn mower as well as non-physical automation that tackles mundane computer processing tasks to free up users to do other things (Robotic Process Automation).

In this unit, you will explore how robotics and automation are used in different industries to solve problems and meet a range of needs. You will explore physical and non-physical 'robots' and how the different hardware, software and data components of a system are used to automate processes. You will design and build a physical robot in response to an identified problem.

The analytical and problem-solving skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment.

Learning aims

In this unit, you will:

A Investigate the use of automation and robotics

B Design an automated solution for an identified need

C Produce an automated solution for an identified need.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate the use of automation and robotics	**A1** Robotics and automation fundamentals **A2** Uses and applications of robotics and automation	A written report exploring how and why robotics and automation have integrated into different industries and society, the benefits they can bring, and any associated drawbacks and wider concerns.
B Design an automated solution for an identified need	**B1** Design documentation	A portfolio of evidence detailing the creation of an automated solution to include: • design documentation for the software solution • record of feedback received and actions taken • evidence of a completed/implemented solution (including initial and refined version) • copy of the solution's source code • test documentation and user feedback • analysis of feedback and evidence of refinement of solution • evaluation of the development, testing and refinement process.
C Produce an automated solution for an identified need	**C1** Coding and connecting an automated solution **C2** Testing an automated solution	

Content

Learning aim A: Investigate the use of automation and robotics

A1 Robotics and automation fundamentals

The fundamental concepts of robotics and automation and their use in automating processes in the real world.

- The fundamental concept that a robot consists of different components that can be combined to form a complete system including:
  - mechanical components
  - sensory components
  - data components
  - control systems.
- How sensors, data, algorithms and devices work together in robotics and automation including:
  - sources of data (e.g. Internet of Things (IoT), sensors, large data sets, AI systems)
  - types of sensors (e.g. light, sound, temperature, moisture)
  - how data is generated from sensors and how this can be measured and visualised
  - how data sources provide the parameters for an algorithm
  - how all components interact in order to control movement and execute tasks.
- Differences between physical robots and Robotic Process Automation (RPA).
- How and why levels of automation vary (e.g. semi-autonomous, fully-autonomous).

A2 Uses and applications of robotics and automation

How robotics, automation and the Internet of Things (IoT) are used in different industries and contexts.

- Use in industry including:
  - farming and agriculture (e.g. environmental control, harvesting)
  - health (e.g. surgical assistance, prosthetics, training, rehabilitation support, service robots)
  - logistics (e.g. picking, order fulfilment, drone delivery)
  - manufacturing (e.g. assembly, welding, painting)
  - police and military (e.g. surveillance drones, bomb disposal).
- Use in society including:
  - transportation (e.g. driverless trains, parking aids, self-driving cars)
  - smart cities (e.g. air quality monitoring, lights, waste management, traffic management)
  - smart homes (e.g. heating, lighting, security, entertainment).
- The wider considerations for individuals and organisations in relation to the adoption and use of robotics and automated systems including:
  - benefits of robotics and automation
  - drawbacks of robotics and automation
  - ethical considerations (e.g. data security, privacy, job loss, AI bias, inequality)
  - when it is appropriate to deploy these systems and when it is not
  - type of system to deploy (e.g. physical robot, automated process, semi-autonomous, fully-autonomous).

Learning aim B: Design an automated solution for an identified need

B1 Design documentation

Define the scope of an automated solution in response to a client brief.

- Overview of the context and summary of the problem.
- Description of the proposed solution.
- Functional and non-functional requirement specifications.
- Algorithm design documentation, including flowcharts, pseudocode.
- Physical system planning including:
  - list of required components (e.g. sensors, motors, actuators, control boards, connections)
  - system diagrams (e.g. network diagram, node block diagram, system schematics).
- Logical system planning including:
  - software requirements (e.g. operating systems, third party applications, application programming interface (API)
  - system's deployment stack
  - addressing and naming schemes
  - system data requirements including:
    - data sources (e.g. cloud databases, live data, connected sensors, computer applications)
    - defining threshold data trigger alerts (e.g. minimum and maximum temperatures, time-based triggers, noise levels)

Learning aim C: Produce an automated solution for an identified need

C1 Coding and connecting an automated solution

Connecting and controlling hardware and software to produce complete automated solutions.

- Use of appropriate programming languages to handle front-end, back-end and physical computing requirements (e.g. Python, C, SQL, Java, Kotlin).
- Use of tools provided by integrated development environments and related code development tools to produce solutions including:
  - use of standard and imported libraries and functions
  - integration of different protocols and device drivers (as required)
  - input/output control
  - handling data (e.g. external data sources, variables, run-time data structures)
  - application of good coding practices to ensure functional and efficient solutions.
- Selection and use of different hardware components in combination to create complete automated solutions including:
  - control devices e.g. Raspberry PI, Arduino, BBC Microbit, smartphone
  - system monitoring and output (e.g. screens, speakers, lights, gauges)
  - physical output and control (e.g. motors, actuators, water pumps)
  - user input (e.g. keyboard, buttons, switches)
  - power supplies (e.g. battery, solar, mains)
  - sensors (e.g. ultrasonic, radar, light, sound, moisture, movement, temperature)
  - memory and storage.

C2 Testing an automated solution

Application of iterative development processes and techniques to test and refine solutions to ensure they are fit for purpose.

- Develop a test plan to ensure the testing of the complete system including coverage of (as appropriate to the solution):
  - software testing (e.g. module, integration)
  - hardware testing (e.g. functional testing, integration testing)
  - automated testing
  - user testing and feedback.
- Document the application of a test plan including:
  - use of success functional and non-functional requirements to inform testing
  - identification of the test to be carried out
  - description of the purpose of the test
  - identification of test data to be used if required (e.g. valid, valid extreme, invalid, invalid extreme, erroneous).
- Document the outcomes of testing including:
  - recording any errors/faults identified
  - describing the system outcomes
  - comparing test outcomes to expected outcomes
  - describing any additional actions required.
- Fix/address any identification of errors or faults.
- Record corrective actions for identified defects.
- Retest to confirm success of corrective actions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate the use of automation and robotics</td><td rowspan="3">A.D1 Evaluate the impact of robotics and automation on different industries and society.</td></tr>
<tr><td>A.P1 Describe how robotics and automation are used in industry and society to meet specific identified needs.
A.P2 Explain the associated benefits, drawbacks and wider considerations of robotics and automation in different industries and society.</td><td>A.M1 Analyse the benefits, drawbacks and wider considerations of robotics and automation and how they impact different industries and society.</td></tr>
<tr><td colspan="2">Learning aim B: Design an automated solution for an identified need</td></tr>
<tr><td>B.P3 Produce a set of designs for an automated solution that meets identified requirements.
B.P4 Review designs with others to identify and inform improvements.</td><td>B.M2 Refine designs in response to feedback, justifying any changes made.</td><td rowspan="3">BC.D2 Use iterative development processes to produce a highly-robust and efficient automated solution that makes effective use of hardware, software and data components.
BC.D3 Evaluate the effectiveness of an automated solution.</td></tr>
<tr><td colspan="2">Learning aim C: Produce an automated solution for an identified need</td></tr>
<tr><td>C.P5 Develop an automated solution using appropriate hardware, software and data components.
C.P6 Test a hardware, software and data components to identify and resolve defects.</td><td>C.M3 Use iterative development processes to produce an automated solution that makes effective use of hardware, software and data components.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim A: (A.P1, A.P2, A.M1, A.D1)

Learning aims B and C: (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- physical computing resources (e.g. motors, sensors and single board computers)
- programming development environments.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate the use of automation and robotics in at least three different industries and in different areas of society. Learners will evaluate the use of different types of automation and robotics, for example physical robots and automated processes, and consider how they are used in different contexts.

The evaluation will look at ways that robotic automation is used to solve problems and meet specific objectives, drawing comparisons between uses in different contexts. The learner will consider different aspects of the solutions, for example physical components and data, and how these impact the quality and application of identified solutions. The evaluation should consider a range of benefits, risks and drawbacks of automation and robotics and the ways that adopting these systems can impact organisations and wider society.

Learners will also explore the ethical factors that can have an impact on the adoption and success of robotics and automation, providing supported value judgements as to the impacts these things can have in specific cases. Overall, the evidence will be logically structured with correct use of technical terms and written at a high standard including the consistent use of correct grammar and spelling.

For Merit standard, learners will analyse robotics and automation in different industries and areas of society. Learners will consider the use of different types of automation and robotics, for example physical robots and automated processes, exploring how they are applied in different contexts.

The analysis will look at ways that these systems are applied to solve problems and meet specific needs. The analysis should consider a range of benefits, risks and drawbacks of robotics and automation and ways that adopting these systems can impact organisations and wider society. Learners will explore ethical factors that can have an impact on the adoption and success of robotics and automation providing examples to support their analysis. Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will describe the use of robotics and automation in different areas of industry and society. Learners will explore the fundamental concepts of robotics and automation, for example the component parts that make up systems and the use of different types of system, exploring how they are applied in different industries and in wider society. Learners will identify and explain ways that these systems are applied to solve problems and meet specific needs. Learners should consider benefits, risks and drawbacks of robotics and automation as well as some of the ethical considerations when adopting automated systems.

Overall, the evidence will be logically structured. It may be basic in parts, for example the range of robotics and automation may not be extensive, and the risks, benefits and drawbacks may be unbalanced or generic. The evidence may contain minor inaccuracies or omissions.

Learning aims B and C

For Distinction standard, learners will demonstrate an iterative approach to produce an effective, high-quality automated solution that integrates hardware, software and data components, to meet most of the user-requirements identified during planning. Time constraints may mean that not all planned requirements are implemented when producing the final solution. Where a learner has not met all the planned user requirements, the requirements that have been implemented will have been done so to a high standard; their solution will handle input and output components effectively and handle data in a way which results in consistently correct outcomes.

At this level, the code for the solution will have an efficient and logical structure and hardware components will have been utilised effectively.

The system will handle user errors and rogue inputs effectively to ensure a highly robust system that consistently performs as expected. The related code will be easily maintainable by a third party through the use of consistent and appropriate naming conventions, fully logical organisation and highly informative commenting.

The solution will provide an excellent user experience through the use of high-quality, effective user interaction (where appropriate), effective input handling, informative guidance and messages to the user, and effective system outputs.

Learners will evaluate the solution against the identified requirements and quality criteria. Learner evaluations will consider its efficiency and effectiveness, and the extent to which it meets the requirements in the scenario. The evaluation will be supported by evidence from the development and testing stages and will provide supported conclusions, and suggest future developments.

For Merit standard, learners will demonstrate an iterative approach to development and testing to produce a robust automated solution that makes effective use of hardware, software and data components to meet identified requirements. Documentation should demonstrate the effective use of testing and feedback to refine the designs and the solution.

Testing should clearly demonstrate how learners have ensured that testing has considered functional and non-functional requirements. A range of suitable testing methodologies should be implemented to ensure that all aspects of the solution, for example software, hardware and data function mostly as expected, and that the system is robust, although some minor issues will persist.

Evidence of testing should demonstrate appropriate use of test plans and apply appropriate, detailed test cases. As part of functional testing at this level it would be expected that a range of valid, valid extreme, invalid, invalid extreme and erroneous test data is used to effectively test the solution.

Any errors, corrective actions and regression testing should be documented.

The solution will meet most of the user requirements, but the implemented solutions may not be the most efficient.

At this level, the code for the solution will have a logical structure. It will make use of precise logic and programming structures which result in correct outcomes. The system will be able to handle a range of user errors and rogue inputs to ensure a fairly robust solution, but some minor issues may persist.

The code will be maintainable by a third party through the use of mostly consistent and appropriate naming conventions, logical organisation and mostly informative commenting.

The solution will provide a good experience through the use of good quality user interaction (where appropriate), effective input handling, informative guidance and messages to the user, and effective system outputs.

For Pass standard, learners will demonstrate development and testing of an automated software solution that makes use of hardware, software and data components to meet identified requirements.

Testing will demonstrate some consideration of functional and non-functional requirements and a range of testing methodologies, but at this level is likely to be unbalanced and focus more heavily on one area, resulting in parts of the system not functioning as intended.

There will be evidence of basic testing but the scope of the testing may mean that some issues persist or only common/obvious errors are considered.

The solution will meet some of the user requirements and will utilise hardware, software and data components, but their use may be inefficient, or may not always function effectively.

At this level the code for the solution will have a mostly logical structure. It will make use of some precise logic and programming structures which result in mostly correct outcomes. The system will handle some user errors and rogue input but some issues may persist.

The solution will provide a reasonable user experience through the use of some appropriate user interaction design, some effective input handling and some effective system outputs.

Learners will provide evidence that they have reviewed the solution with others and will provide evidence of how that feedback was used to develop the solution further.

Links to other units

This unit links to:

- Unit 4: Programming
- Unit 18 Internet of Things
- Unit 21: Introduction to Artificial Intelligence (AI).

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- problem solving
- analysis
- ethics.

Unit 23: Emerging Trends and Technologies

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners will gain knowledge of computing technologies and how to interact with them, and how this is evolving. They will design and create a cloud-based solution to meet identified requirements.

Unit introduction

The way we use and interact with computers, along with the technologies that are utilised to meet people's needs, is constantly evolving. In recent years we've seen significant developments in mobile technologies, digital assistants, and virtual reality to name just a few. We've also seen an increase in the way individuals and organisations utilise cloud technologies to solve a range of issues.

In this unit, you will first explore the developments in computing and how these technologies impact on users and larger society. You will then learn about approaches to designing, developing and testing cloud-based solutions to identified problems. You will respond to a set of client requirements by analysing the client requirements to produce a proposal and design documentation for a complete solution. You will produce a cloud-based solution that utilises front-end and back-end components demonstrating an iterative approach to development through the testing and refinement of your solution. Finally, you will evaluate your solution against the identified requirements.

Learning aims

In this unit, you will:

A Investigate developments in computing

B Design a cloud computing solution to meet identified requirements

C Deploy a cloud computing solution to meet identified requirements.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate developments in computing	**A1** Developments in computing technologies **A2** Developments in human computer interaction	A written report exploring the developments in computing and their impact on different industries and society.
B Design a cloud computing solution to meet identified requirements	**B1** Planning a cloud computing solution	A portfolio of evidence detailing the development, testing and monitoring of a cloud-based solution, which may include: • planning documentation for the solution • record of feedback received about plans and actions taken • completed solution • testing and monitoring documentation • user feedback • analysis of feedback and evidence of refinement of solution • evaluation of the development, testing and refinement process.
C Deploy a cloud computing solution to meet identified requirements	**C1** Development of a cloud-based solution **C2** Monitoring and reviewing cloud-based solutions	

Content

Learning aim A: Investigate developments in computing

A1 Developments in computing technologies

How current and emerging trends and technologies impact on different industries and society.

- Developments in computing power (e.g. processing and memory storage, and their impact on use and application of digital systems).
- Developments in communications technologies (e.g. Bluetooth, Wi-Fi, 5G and fibre optics and their impact on use and application of digital systems).
- The basics of quantum computing.
- The differences between quantum computing and traditional computer systems.
- The key concepts and applications of neural network architectures.
- The basics of blockchain technologies and smart contracts.
- The use and application cloud technologies including:
  - common cloud delivery models including:
    - IaaS (Infrastructure as a Service)
    - PaaS (Platform as a Service)
    - SaaS (Software as a Service)
    - DaaS (Data as a Service.
  - developments in the use and application of cloud computing such as:
    - serverless computing
    - containers
    - cloud gaming (e.g. Google Stadia, Xbox cloud gaming)
    - artificial intelligence and machine learning.
- Developments in manufacturing and prototyping (e.g. CAD/CAM, 3D printing and laser cutters).

A2 Developments in human computer interaction

How current and emerging trends and technologies impact the way users make use of and interact with digital technologies.

- The uses and application of augmented and virtual reality.
- The fundamental concepts of mixed reality and its uses.
- Trends in user interface design.
- Fundamental concepts of user experience (UX) design.
- Advanced HCI technologies (e.g. haptics in medical/surgical support systems and head/eye tracking in accessibility systems).
- Natural Language Processing and its applications.

Learning aim B: Design a cloud computing solution to meet identified requirements

B1 Planning a cloud computing solution

Define the scope of the proposed cloud solution in response to a client brief.

- Overview of the context and summary of the problem.
- Establishing of functional and non-functional requirements through inclusion of (as appropriate):
  - identifying the services to be migrated to the cloud (e.g. email, office applications, data storage, data processing and server functions)
  - impacts of cloud migration (e.g. cost, removal/reduction of local infrastructure, excess capacity, availability on demand of storage and processing)
  - challenges of cloud migration (e.g. network access requirements, availability of service, legal requirements and security).
- Establishing key performance indicators (KPIs) that will be used to measure the success of the proposed solution (e.g. speed, bandwidth and throughput).
- Review and select a cloud service provider (e.g. Amazon Web Services (AWS), Google Cloud Platform, Microsoft Azure) on which to deploy the solution.
- Consideration and selection of tools provided by service providers to meet functional and non-functional requirements and KPIs (e.g. load balancing, scalability, threat detection, identity and access management).
- Potential risks of the proposed solution and how these can be mitigated.

Learning aim C: Deploy a cloud computing solution to meet identified requirements

C1 Development of a cloud-based solution

Implement a cloud-based solution to meet identified requirements.

- Selecting and use of cloud tools and resources to establish a cloud deployed solution including:
  - virtual private cloud
  - virtual machines (e.g. AWS EC2, GCP Compute engines VM)
  - cloud storage
  - infrastructure and security management including:
    - addressing
    - firewalls and routing tables
    - identity and access management
    - load balancing
    - scaling.
- Deployment of database tools in the cloud to meet identified needs (e.g. application back-end processes, e-commerce site management and data mining).
- Deployment of webservers and associated tools in the cloud to meet identified needs.

C2 Monitoring and reviewing cloud-based solutions

The use of testing and monitoring methodologies to ensure a cloud-based solution meets identified needs.

- Different types of testing (e.g. functional, user, performance, and stress and security).
- Selecting suitable test users.
- Gathering feedback from users.
- Use of monitoring tools provided by cloud service providers (e.g. Azure Monitor, Amazon CloudWatch, Google cloud monitoring).
- Responding to issues and providing continued improvements and support such as:
  - security issues and updates (e.g. applying patches and responding to emerging threats or attacks)
  - software updates (e.g. upgrading operating systems or application software)
  - compatibility issues (e.g. access by different operating systems and browser/plug-in compatibility)
  - changing user requirements (e.g. diversification of service and adding additional functionality to cloud service).

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate developments in computing</td><td rowspan="3">A.D1 Evaluate the impact that developments in computing have on different industries and society.</td></tr>
<tr><td>A.P1 Describe current and emerging trends and technologies and their how they impact different industries and society.
A.P2 Describe how developments in computing impact users that make use of and interact with digital technologies.</td><td>A.M1 Analyse how developments in computing impact different industries and society.</td></tr>
<tr><td colspan="2">Learning aim B: Design a cloud computing solution to meet identified requirements</td></tr>
<tr><td>B.P3 Produce plans for a cloud computing solution that meets identified requirements.
B.P4 Review designs with others to identify and inform improvements.</td><td>B.M2 Refine designs in response to feedback, justifying any changes made.</td><td rowspan="3">BC.D2 Evaluate the design and development of the refined cloud-based solution against identified requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Deploy a cloud computing solution for an identified client</td></tr>
<tr><td>C.P5 Develop a cloud-based solution to meet identified requirements.
C.P6 Test and monitor a cloud-based solution to identify and implement improvements.</td><td>C.M3 Use iterative development methodologies to review and refine a cloud-based solution.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim A: (A.P1, A.P2, A.M1, A.D1)

Learning aims B and C: (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- an integrated development environment compatible with chosen programming languages
- web development tools
- database systems
- cloud deployment environments.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners evaluate the developments in technology in at least three different industries and in different areas of society. Learners will evaluate the impact of different technologies, which will include an exploration of trends in design, developments in technologies and ways in which human computer interaction has developed.

The evaluation will look at the ways in which computing technology is used to solve problems and meet specific objectives, drawing comparisons between uses in different contexts. The learner will consider different aspects of the solutions, for example the physical systems required, the connections and data, and how these impact the quality and application of identified solutions, as well as availability to different organisations and users. The evaluation should consider a range of benefits, risks and drawbacks of the identified technologies and ways that adopting these systems can impact organisations and wider society.

Learners will provide supported value judgements as to the impact developments in technology can have in specific cases. Overall, the evidence will be logically structured with correct technical information.

For Merit standard, learners will analyse developments in technology in different industries and areas of society. Learners will consider the use of different types of technology, and how the changes impact on organisations, individuals and society as a whole, exploring how they are used in different contexts.

The analysis will look at the ways in which these technologies are applied to solve problems and meet specific needs. The analysis should consider a range of benefits, risks and drawbacks of identified technologies and ways that developments, and adopting these systems, can impact organisations and wider society.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will describe the current and emerging trends in computing technologies, including ways in which users interact with systems has developed. Learners will explore how and why changes in technology occur, and the fundamental component parts that make up systems how these improve/evolve over time. The learner will explore how different technologies are applied in different industries and in wider society, and how changes in these technologies impact on the organisation and individuals. Learners will identify and explain ways that these technologies are applied to solve problems and meet specific needs. Learners should consider benefits, risks and drawbacks of the technologies that they identify.

Overall, the evidence will be logically structured. It may be basic in parts, for example the range of technologies may not be extensive, and the risks, benefits and drawbacks may be unbalanced or generic. The evidence may contain minor inaccuracies or omissions.

Learning aims B and C

For Distinction standard, learners will use evidence from their planning documents, deployment testing and monitoring, and the feedback of others to support a comprehensive evaluation of their solution in relation to the identified requirements. The evaluation will provide value judgements of the refinements they made to the solution throughout development, and how the refined solution meets the identified requirements. The learner will consider alternative ways that the problem could have been solved, and why the final solution was chosen.

For Merit standard, learners will utilise the feedback of others to refine the quality and appropriateness of their solution design. Learners will provide evidence of their initial designs, a record of feedback received and evidence of how the feedback was considered and implemented. They will provide evidence that includes the initial and refined designs. Learners will provide a justification of any changes made during the design stage with reference to the identified requirements.

At this level, the planning documentation should be of sufficient quality, clarity and detail so that a third party could, with minimal difficulty, use them create the proposed solution.

Learners will demonstrate an iterative approach to development and testing to produce a robust cloud-based stack solution that makes effective use of the appropriate front-end and back-end tools to meet identified requirements.

Learners should clearly demonstrate how they have tested and monitored the deployed solution, with consideration of how the solution meets functional and non-functional requirements. Learners will demonstrate a range of testing methodologies (e.g. stress testing, functional testing, security testing) to ensure that the solution is robust, although some minor issues will persist.

Evidence of testing should demonstrate appropriate use of test plans and apply appropriate, detailed unit test cases (UTCs), where appropriate the test cases should identify the data to be used with consideration of valid, valid extreme, invalid, invalid extreme, erroneous test data.

The solution will meet most user requirements but the implemented solutions may not be the most efficient.

At this level, any code produced for the solution will have a logical structure. It will make use of precise logic and programming structures which result in correct outcomes. The solution will handle a range of user errors and rogue inputs to ensure a fairly robust system, but some minor issues may persist. The code will be maintainable by a third party through the use of mostly consistent and appropriate naming conventions, logical organisation and mostly informative commenting.

The solution will provide a good experience through good quality user interface design, mostly effective input handling, generally informative guidance and messages to the user, and mostly effective output formatting.

For Pass standard, learners will develop a set of design documentation for a cloud-based solution that utilises front-end and back-end tools. The design documents should clearly identify the functional requirements, the non-functional requirements and KPIs which the system will be judged against. The plans should include a review of different cloud service providers and the tools they offer identifying which tools will be utilised to meet the identified requirements.

Learners will provide evidence of having received feedback on their plans, developing their solution accordingly.

At this level, plans must be of a reasonable quality, so that a third party could mostly create the proposed solution, but there may be some minor difficulties due to lack of detail or clarity in places.

Learners will demonstrate an appropriate approach to development, testing and monitoring of a cloud-based solution demonstrating that they can use front-end and back-end tools and components to meet identified requirements. Although at this level some errors may persist.

Testing will demonstrate some consideration of functional and non-functional requirements and a range of testing methodologies, but at this level is likely to be unbalanced and focus more heavily on functional testing.

There will be basic evidence of the use of appropriate tools to monitor the system and respond to issues in order to improve the solution.

The solution will meet some of the user-requirements and may be inefficient.

At this level any code produced for the solution (if required) will have a mostly logical structure. It will make use of some precise logic and programming structures which result in mostly correct outcomes. The code will handle some user errors and rogue inputs but some issues may persist. The code will be mostly maintainable by a third party through the use of some consistent and appropriate naming conventions; some logical organisation; and some informative commenting.

The solution will provide a reasonable user experience through the use of basic user interface design, some effective input handling, some informative guidance and messages to the user, and some effective output formatting.

Learners will provide evidence that they have reviewed the solution with others and will provide evidence of how that feedback was used to develop the solution further.

Links to other units

This unit links to:

- Unit 4: Programming
- Unit 6: Website Development
- Unit 13: Software Testing
- Unit 15: Cloud Storage and Collaboration Tools
- Unit 25: Full Stack Development.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- planning and time management
- problem solving.

Unit 24: Technical Fundamentals for Computing Professionals

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners will study the core knowledge and skills required to make them effective members of an IT workplace. They will design and create a computer infrastructure solution to meet client requirements.

Unit introduction

Organisations are increasingly reliant on IT to perform everyday tasks, deliver goals and ensure customers' needs are met. This means that delivery of high-quality computing solutions is vital for an organisation to be successful, and these are increasingly integrated into every aspect of an organisation. Modern computing professionals are increasingly required to perform many different roles, are integrated into larger teams and interact with a wide range of stakeholders. To be effective in any of these roles, computing professionals should have a core set of key skills. These key skills can be technical in nature, but often require an understanding of wider issues that impact not only the ogranisation that they work for, but on society as a whole.

In this unit, you will first explore the basic coding and scripting skills that will be useful in a range of technical roles. You will explore the fundamentals of coding and explore how to use shell scripting to perform and automate work tasks. You will then explore wider issues relating to the use of technology that can impact on the workplace. Finally, you will learn about network infrastructure and how to design a network and related systems to meet identified needs.

This unit builds on knowledge from *Unit 1: Information Technology Systems – Strategy, Management and Infrastructure* and *Unit 11: Cyber Security and Incident Management.*

The analytical and problem-solving skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment, for example as a junior software developer.

Learning aims

In this unit, you will:

A Explore the mathematics, logic and processes of computer systems

B Investigate issues relating to the use of digital systems

C Design a computer infrastructure solution.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore the mathematics, logic and processes of computer systems	**A1** Number systems **A2** Coding and scripting	A portfolio of evidence detailing the use of shell scripts and computer programs to meet a range of identified needs.
B Investigate issues relating to the use of digital systems	**B1** Cybersecurity **B2** Health and safety issues **B3** Moral and ethical issues	A report analysing potential issues, in relation to technology for an identified organisation, including: • a review of its current practices and systems and identification of: o potential security issues o social, moral and ethical considerations • suggestions for how identified issues can be addressed • an evaluation of the impact of implementing suggestions on the company and wider stakeholders.
C Design a computer infrastructure solution	**C1** Computer systems architecture **C2** Memory and storage **C3** Data communication **C4** Network design	A portfolio of evidence detailing the design of a computer infrastructure solution to meet the needs of an identified organisation, which may include: • design documents for an infrastructure solution • feedback on the documentation/designs collected from others • improved version of the documentation /design • written justification of design decisions • an evaluation of the designs.

Content

Learning aim A: Explore the mathematics, logic and processes of computer systems

A1 Number systems

The use and application of mathematical principles and number systems within computing systems.

- Number systems used in computer systems, including:
  - units and scales of digital data (bit, byte, kilobyte, megabyte)
  - binary
  - hexadecimal.
- Why computers use binary and how it is used to represent all data, e.g. number, characters, image sound.
- Mathematical operations performed on denary, binary and hexadecimal number systems, including:
  - conversion of numbers between number systems
  - performing addition, subtraction, division and multiplication (including binary shifts)
  - use of binary to represent negative and floating-point numbers
  - the concept of overflow errors
  - relationship between binary and file size
  - calculation of files sizes for sound, text and images.

A2 Coding and scripting

Fundamental skills and knowledge for developing coding and scripting solutions to solve problems and automate processes.

- The use of computational thinking to explore problems and apply solutions (decomposition, pattern recognition, abstraction, algorithmic design).
- Mathematical operators and their application (add, subtract, divide, multiply, integer division, modulus).
- Relational operators and their application (==, <, >, <>, <=, >=).
- Boolean operators and their application (NOT, AND, OR).
- Data types used in programming, e.g. string, integer, float/real, Boolean.
- Declaration and use of constants and variables.
- Run-time data structures, e.g. list, array, tuple, dictionary.
- The use of appropriate sequencing in program structure, including:
  - most efficient and logical order of actions
  - the correct order of actions to ensure accurate outputs and avoid errors.
- The structure and application of selection (branching), including:
  - IF statements, e.g. IF, ELSE, ELSEIF (ELIF)
  - switch/case.
- The structure and application of iteration, including:
  - count-controlled loops
  - condition-controlled loops.

- Shell scripting (e.g. Bash, PowerShell, Command Prompt) to automate routine administrative tasks, including:
  - file management, e.g. move, copy, delete, rename
  - installing, removing and updating software
  - batch processing
  - system monitoring.

Learning aim B: Investigate issues relating to the use of digital systems

B1 Cybersecurity

The fundamental concepts of threats to data and systems, and ways that threats can be mitigated.

- The concept that threats can be internal (from within the organisation) and external (from outside of the organisation) and motivation for these, e.g. financial gain, industrial sabotage, disruption.
- Internal threats to the data**,** including:
  - intentional security breach by a rogue or disgruntled employee(s)
  - accidental security breach
  - poorly designed or implemented security policies
  - incorrectly configured systems
  - damage to computer systems (intentional or accidental).
- The external threats to the data**,** including:
  - unauthorised access to systems, e.g. hackers
  - malware, e.g. viruses, spyware, rootkit, ransomware
  - social engineering, e.g. phishing, vishing, pharming
  - changes/updates to systems and software
  - natural disasters, e.g. fire, flood, earthquake.
- The concept of data privacy.
- The trade-offs between ensuring data is secure and private, and ensuring access for all stakeholders to required data, information, or systems.
- Ways to mitigate threats to security and privacy, including:
  - installing and configuring firewalls
  - installing, using, and updating anti-malware software
  - device hardening
  - user access levels
  - security policies, e.g. passwords, limiting concurrent log-in, restricted log-in times
  - additional access restrictions, e.g. two-factor authentication, biometrics, physical locks/doors.
- Legislative requirements for ensuring the security and privacy of data in relation to the network, connected devices and users.

B2 Health and safety issues

The knowledge, skills and behaviours required by computing professionals in order to ensure a safe and healthy workplace.

- Ensuring healthy and safe use of digital systems working environment, including:
  - common issues relating to the use of digital systems, including:
    - repetitive strain injuries (RSI)
    - back pain and poor posture
    - headaches and eyestrain
    - risks to physical safety issues, e.g. tripping on cabling, electric shock when maintaining equipment
  - ways to mitigate potential health and safety issues, including:
    - workstation layout and design
    - ergonomic equipment, e.g. keyboards, adjustable and supportive chair, wrist supports
    - policies and procedures for the use of equipment, e.g. breaks, regular eye tests, device settings
    - cable management
    - safe maintenance procedures, e.g. electricity isolation, anti-shock/anti-static bands
  - understanding the importance of fail-safe and zero errors in safety-critical systems.

B3 Moral and ethical issues

The knowledge, skills and behaviours required by computing professionals in order to ensure an inclusive workplace.

- The concepts of 'equality' and 'equity' and how these apply to creating and deploying digital systems.
- How to address accessibility considerations for the use of computers systems:
  - software-based accessibility considerations, including:
    - screen reader support, e.g. sensible/logical order of information, alt-text
    - interface design, e.g. alternative layout options, adjustable colours and fonts
    - voice recognition
  - hardware-based accessibility considerations, including:
    - alternative input devices, e.g. Braille keyboards, sip and puff systems, eye tracking
    - alternative output devices, e.g. Braille display, haptic feedback.
- The digital divide and the reasons why it may exist in varying degrees, including:
  - economic
  - geographic
  - social
  - cultural.

Learning aim C: Design a computer infrastructure solution

C1 Computer systems architecture

The features and characteristics of a computer's component parts and how these impact on its performance and use.

- The purpose and characteristics of components of the central processing unit (CPU), including:
  - arithmetic logic unit (ALU)
  - control unit (CU)
  - cache
  - registers.
- The purpose and characteristics of general and special registers and their impact on the way computer systems perform, including:
  - general purpose registers
  - special registers:
    - accumulator
    - instruction register
    - memory address register (MAR)
    - memory data register (MDR)
    - program counter.
- The actions performed and the role of each component during the fetch-execute cycle.
- Factors affecting the use and performance of a CPU, including:
  - clock speed
  - number of cores and threads
  - cache size
  - cooling
  - power management settings
  - overclocking.
- How and why the performance of CPUs designed for mobile devices differs from CPUs designed for desktop computers.
- The purpose and characteristics of graphical processing units (GPUs).
- The role of the operating system in managing and controlling internal components.

C2 Memory and storage

The fundamental concepts of how data is stored within computer systems.

- The difference between primary storage (memory) and secondary storage, and why each is needed within a computer system.
- The purpose and characteristics of different types of memory, including:
  - random access memory (RAM)
  - read only memory (ROM)
  - virtual memory.

- The purpose and characteristics of different types of storage, including:
  - internal storage, e.g. hard disk drive, solid state drive
  - removable or external storage, e.g. USB flash drives, external hard drives, optical media
  - data back-up and recovery systems, e.g. RAID arrays, network attached storage (NAS), storage area networks (SAN), magnetic tape.
- The benefits and drawbacks of different storage devices and media in in different cases.
- The benefits and drawbacks of cloud resources for storage and back-up systems in comparison to 'on premise' systems.
- The role of the operating system in managing and controlling memory and storage.

C3 Data communication

The concepts, processes and implications of data transmission in and between computer systems.

- The concept of layers to describe how data is transferred, and how applications communicate, over a network.
- The role of data packets in transmitting data over a network:
  - contents and structure of a data packet
  - the purpose and function of each component of the data packet
  - the concept of packet switching.
- IP and MAC addresses and their purpose.
- The purpose and function of common network protocols, e.g. HTTP/HTTPS, FTP, IMAP, TCP/IP.
- Methods of connecting devices and transmitting data across and between computer systems, e.g. Ethernet, Wi-Fi, Bluetooth.

C4 Network design

How to design a computer network to meet identified needs.

- Planning a network to meet the identified organisational and business goals, and technical requirements that need to be met, including:
  - data sharing
  - resource sharing
  - communication
  - creation of larger systems
  - operational goals, e.g. productivity improvements, diversification, development of new or improved products.
- Network size, small office/home office (SOHO), small and medium-sized business (SMB), large enterprise.
- Design aims and requirements for network (LAN/WAN) and how these can be met, including:
  - scalability
  - availability
  - redundancy
  - performance, e.g. latency, bandwidth, large traffic volumes, distance
  - security, e.g. malware, unauthorized access, loss/theft of device.

- Benefits and drawbacks of implementing infrastructure using an on-site, cloud- based or hybrid models, including consideration of:
  - Network as a Service (NaaS)
  - Platform as a Service (PaaS)
  - Software as a Service (SaaS)
  - Data as a Service (DaaS)
- Network physical design schemes, including:
  - flat design and hierarchical design, including related topologies
  - network diagrams and physical layout
  - LAN/WAN equipment requirements, e.g. server, switch, router
  - network client device requirements, e.g. type of device, technical specifications, peripherals.
- Logical network design, including:
  - IP addressing
  - IPV4 versus IPV6, private versus public IP
  - naming schemes
  - virtual LAN (VLAN) design issues.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Explore the mathematics, logic and processes of computer systems		**A.D1** Produce a set of computer programs and scripts that are highly-robust and make effective and efficient use of appropriate programming structures to meet identified needs.
A.P1 Produce a set of computer programs and scripts that make use of appropriate programming structures to meet identified needs.	**A.M1** Produce a set of computer programs and scripts that make effective use of appropriate programming structures to meet identified needs.	
Learning aim B: Investigate issues relating to the use of digital systems		**B.D2** Evaluate the impact that implemented suggestions to deal with issues relating to computer systems would have on an organisation and its stakeholders.
B.P2 Describe the issues relating to computer systems use in an identified organisation. **B.P3** Suggest ways that issues relating to the use of computer systems could be dealt with in an identified organisation.	**B.M2** Analyse how implementing suggestions to deal with issues relating to computer systems would impact on an organisation and its stakeholders.	
Learning aim C: Design a computer infrastructure solution		**C.D3** Evaluate the refined computer infrastructure design documents against the client requirements.
C.P4 Design a computer infrastructure solution to meet an organisation's needs. **C.P5** Review the infrastructure solution design with others to identify potential improvements.	**C.M3** Refine the computer infrastructure design in response to feedback, justifying any changes made.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. Section 6 Internal assessment gives information on setting assignments and there is also further information on our website.

There is a maximum number of three summative assignments for this unit.

The relationship of the learning aims and criteria is:

Learning aim A: (A.P1, A.M1, A.D1)

Learning aim B: (B.P2, B.P3, B.M2, B.D2)

Learning aim C: (C.P4, C.P5, B.M3, C.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- an integrated development environment compatible with chosen programming languages
- diagramming software for creating network plans.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will produce a set of shell scripts that would automate a number of administrative tasks and computer programs (code) for that demonstrate a comprehensive understanding of a range of fundamental coding conventions. Learner solutions will have efficient and logical structures, and will make use of precise logic and programming constructs throughout. The scripts and code will result in consistently correct outcomes. Where appropriate, the code will handle user errors and rogue inputs effectively to ensure highly robust code.

The solutions will provide an excellent user experience through the appropriate use of effective input handling, informative guidance and messages to the user, and effective output formatting.

Learners will provide well-organised and clear evidence that show the scripts and code created, the purpose of each and the operations carried out.

For Merit standard, learners will produce a set of shell scripts that would automate a number of administrative tasks and computer programs (code) that demonstrate a good understanding of a range of fundamental coding conventions. At this level, the scripts and code will have logical structures, but may not always be the most efficient solution. Learner solutions will make use of precise logic and programming structures which result in correct outcomes. Where appropriate, the code solutions will handle a range of user errors and rogue inputs to ensure a fairly robust program, but some minor issues may persist.

The solutions will provide a good experience through the use of mostly effective input handling, generally informative guidance and messages to the user, and mostly effective output formatting.

Learners will provide evidence that shows the scripts and code created, the purpose of each and the operations carried out.

For Pass standard, learners will produce a set of shell scripts that would automate a number of administrative tasks and computer programs (code) that demonstrate a basic understanding of a range of fundamental coding conventions.

Learner solutions will meet some of their intended aims and may be inefficient. At this level the solutions will have a mostly logical structure. They will make use of some precise logic and programming structures which result in mostly correct outcomes. Where appropriate, the code will handle some user errors and rogue input but some issues may persist.

The solutions will provide a reasonable user experience through the use of some effective input handling, some informative guidance and messages to the user, and some effective output formatting.

Learners will provide evidence that shows the scripts and code created, the purpose of each and the operations carried out but there may be some errors or omissions.

Learning aim B

For Distinction standard, learners will evaluate their recommendations for solutions to identified cybersecurity, health and safety, as well as moral and ethical issues. They will consider the impact that their introduction will have on the organisation and its stakeholders.

Learners must provide reasoned and realistic justifications of the impact the solutions have in relation to a specific identified organisation. They will support their justification with relevant and well-chosen contextual examples. The evaluation and justification will be informed by a balanced, wide-ranging review of the positive and negative aspects of the recommendations they have made in comparison to alternatives.

For Merit standard, learners will provide a clear, accurate and well-reasoned analysis of their suggested solutions to relevant cybersecurity, health and safety, as well as moral and ethical issues, with consideration of the impact that their introduction will have on the organisation and its stakeholders.

Learners will show a clear link to the organisation's requirements and the suggested solutions.

The analysis will be balanced and supported by clear examples.

The evidence will be technically accurate and demonstrate good quality written or oral communication.

For Pass standard, learners will produce a formal report that describes cybersecurity, health and safety, as well as moral and ethical issues relating to the use of computer systems. The learner's report will provide details of solutions to computer-related issues.

Learners will show an understanding of some of the organisation's requirements, but they may rely on more generic assertions.

The evidence will be mostly accurate and demonstrate appropriate written or oral communication.

Learning aim C

Learners are expected to provide evidence that they have planned a computer infrastructure network to meet the requirements of an identified organisation.

The specification that is given to learners must be sufficiently complex to give them scope to demonstrate the appropriate range of skills. For example, it must include more than one network type, e.g. wired and wireless, and include user requirements such as shared files, folders and printers, email and intranet access as well as a range of devices and users with different needs.

For Distinction standard, learners will evaluate their infrastructure design with particular focus on how effectively the solution meets the identified requirements. Learners will provide a reasoned justification of their design and will reach reasoned and valid conclusions relating to the needs of the identified organisation and specific users.

The evaluation and justification will be informed by a balanced, wide-ranging review of the positive and negative aspects of the recommendations they have made in comparison to alternatives.

For Merit standard, learners will utilise the feedback of others to refine the quality and appropriateness of their infrastructure design. Learners will provide evidence of their initial designs, a record of feedback received and evidence of how the feedback was considered and implemented. They will provide evidence that includes the initial and refined designs. Learners will provide a justification of any changes made during the design stage with reference to organisational needs and the needs of individual users.

At this level, the design documentation should be of sufficient quality, clarity and detail so that, if required, a third party could, with minimal difficulty, use them create the proposed solution.

For Pass standard, learners will produce a design for a computer infrastructure solution to meet the needs of an identified organisation. The proposal should provide sufficient detail that a third party would be clear as to the scope of the intended solution and provide approval to continue the process based on its content.

Learners will produce a set of design documentation for a substantial infrastructure solution that utilises a range of hardware and software. The design documents should clearly show physical and logical network designs and provide specifications for devices that will meet a range of different user needs.

Learners should show an understanding of how to implement networks and related hardware in an appropriate and legal way.

Learners will provide evidence of having received feedback on their designs, developing their designs accordingly.

At this level, the design documentation must be of a reasonable quality, so that a third party could mostly create the proposed solution, but there may be some minor difficulties due to lack of detail or clarity in places.

Links to other units

This unit builds on content covered in the following units:

- Unit 1: Information Technology Systems – Strategy, Management and Infrastructure
- Unit 11: Cyber Security and Incident Management.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- planning and organising
- problem solving
- decision making.

Unit 25: Full Stack Development

Level: 3
Unit type: Internal
Guided learning hours: 60

Unit in brief

Learners will study full stack development that is used to solve computing problems. They will design and create a full stack solution to meet client requirements.

Unit introduction

A modern software development team is made up of a wide range of people with a variety of skills. Computer systems often require a number of front-end and back-end systems that leverage a range of technologies. Even though many developers specialise in one area of the complete deployment stack, it is vital to understand the whole deployment stack in order to effectively develop and integrate your work as part of a larger team.

In this unit, you will first explore the use and application of full stack development and how these tools and technologies are implemented to solve problems. You will then learn about approaches to designing, developing and testing full stack solutions to identified problems. You will respond to a set of client requirements by analysing the client requirements to produce a proposal and design documentation for a complete solution. You will produce a full stack solution that utilises the full deployment stack, demonstrating an iterative approach to development through testing and refinement of your solution. Finally, you will evaluate your solution against client requirements.

Learners are expected to have a fundamental understanding of programming before starting this unit so it is recommended that this unit should be delivered after *Unit 4: Programming*.

The analytical and problem-solving skills and knowledge that you develop in this unit will prepare you for entry to higher education to study a range of degrees. This unit will also help you to progress to an IT apprenticeship or to employment, for example as a junior software developer.

Learning aims

In this unit, you will:

A Explore tools and technologies for full stack development

B Design a full stack solution for an identified client

C Develop a full stack solution for an identified client.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Explore tools and technologies for full stack development	**A1** Concept of full stack development **A2** Implications of full stack development	A written report exploring how and why full stack development is utilised, the benefits it can bring, and any associated drawbacks and wider concerns.
B Design a full stack solution for an identified client	**B1** Software project proposal **B2** Software design documentation	A portfolio of evidence detailing the development and testing of a software solution, which may include: • design documentation for the software solution • completed software solution (including initial and refined version) • copy of the software solution's source code • test documentation and user feedback • analysis of feedback throughout design and development, and evidence of refinement of designs and solution • evaluation of the development, testing and refinement process.
C Develop a full stack solution for an identified client	**C1** Creating software solutions **C2** Developing high-quality software solutions **C3** Testing and reviewing software solutions	

Content

Learning aim A: Explore tools and technologies for full stack development

A1 Concept of full stack development

The uses and applications of full stack programming.

- Overview of full stack development including:
  - the concept of the stack
  - how it may be structured
  - how it is applied in different solutions.
- The application of full stack programming skills including:
  - development of complete small-scale solutions
  - prototyping and proof of concept
  - support of front-end and back-end teams
  - testing and review of larger scale projects.
- Technologies used to form a stack including:
  - front-end (e.g. HTML, JavaScript, CSS,)
  - back-end (e.g. PHP, NodeJS, .Net)
  - database (e.g. MySQL, PostgresSQL, MongoDB)
  - version control (e.g. Git, CVS, Apache Subversion)
  - infrastructure (e.g. AWS, Microsoft Azure, Virtualisation, Containers).
- Common stacks used in the computing industry (e.g. LAMP, LEMP, MEAN, Django).
- Common software engineering approaches to develop software solutions:
  - investigate
  - design
  - develop
  - test
  - review.
- Key features of iterative methodologies to include:
  - focus on speed of development of product
  - balance between quality of product and number of features (e.g. lower quality with more features and higher quality product with fewer features)
  - rapid response to changes (e.g. changes in user requirements, available technologies and legislation)
  - planning and allocation of resources that can be complex.
- Features of different software development life cycle (SDLC) methodologies, (e.g. agile (Kanban, Scrum)), automated processes (continuous integration, continuous deployment, continuous delivery) and how they link to full stack programming.

A2 Implications of full stack development

The wider considerations for individual developers and organisations in relation to the utilisation of full stack technologies.

- Benefits and drawbacks of full stack development.
- Data security and privacy legislation (e.g. GDPR in Europe).
- Trade-offs between allowing information to be public and keeping information private and secure.
- Use of third-party application programming interfaces (APIs).
- Accessibility considerations of deployed systems.
- Availability and compatibility of systems for users.
- Selection of cloud service providers (e.g. AWS, Microsft Azure) to support deployment including:
  - availability
  - performance
  - security
  - costs
  - available tools
  - compatibility with legacy systems.

Learning aim B: Design a full stack solution for an identified client

B1 Software project proposal

Define the scope of the proposed solution in response to a client brief.

- Overview of the business context and summary of the problem.
- Description of the proposed solution.
- Establishment of functional and non-functional requirements.
- Establishment of key performance indicators (KPIs) that will be used to measure the success of the proposed solution.
- Potential risks of the proposed solution (e.g. increased security risks, adding new services, competing in new markets and meeting timescales).
- Potential implications of the new solution for the business (e.g. impacts on business processes and infrastructure and resource requirements).
- Wider and contextual considerations:
  - technical considerations (e.g. web/third-party APIs, current practice in the infrastructure and software design, emerging technologies, complexity, and reliability of potential solutions and uniqueness of concept)
  - legal considerations (e.g. current and relevant local and international legal requirements, cost and time involved in ensuring compliance)
  - operational considerations (e.g. how well the proposed software solution would meet client needs, potential impact on business processes and business infrastructure)
  - sustainability considerations (e.g. energy use, environmental impact, replacement and disposal of equipment)
  - additional considerations (e.g. security and privacy concerns).

- Justification of the proposed solution, including:
  - the extent to which the proposal meets functional and non-functional requirements
  - how risks will be mitigated and other implications considered
  - consideration of wider and contextual considerations.

B2 Software design documentation

Appropriate design documentation to produce detailed plans for a full stack solution based on an approved project proposal.

- Application of logical analysis, problem-solving skills, process approach and algorithmic thinking, including:
  - decomposition of problems into smaller more easily solvable components
  - abstraction to remove unnecessary detail and focus on only that which is important
  - planning step-by-step approaches to solve decomposed problems
  - reverse engineering of existing solutions to similar problems.
- Design documents used during design of software solutions:
  - functional and non-functional requirements specifications
  - algorithm design documentation, including flowcharts and pseudocode
  - architectural and infrastructure designs to demonstrate the systems deployment stack, including network diagrams, logical architecture diagram and UML diagrams
  - visual design documentation including visual assets design, colour palettes and user interface layouts and behaviours
  - data requirements design, (e.g. entity relationship diagrams (ERDs) and data dictionaries)
  - accessibility and inclusivity considerations, (e.g. alternative layouts, support for inclusive technologies, user ability levels and cultural and religious sensitivity).
- Identification and justification of components that are suitable for reuse, including:
  - reusing or refactoring code produced for previous projects
  - reusing or refactoring code produced by others
  - use of digital content (e.g. images, code and text) produced by the developer or others.
- Documenting sources of reused content (e.g. images, code and text) and clear evidence of licensing and permissions to ensure intellectual property rights are not infringed.
- Application of interactive development principles to software design, including:
  - who may be needed to involve to provide feedback on design
  - how to analyse and use feedback to improve the designs
  - gaining approval of designs
  - sign off at design stage and transition to development stage.

Learning aim C: Develop a full stack solution for an identified client

C1 Creating software solutions

The constructs and techniques for developing complete software solutions that utilise back-end and front-end processes.

- The use of computational thinking to explore problems and apply solutions (e.g. decomposition, pattern recognition, abstraction and algorithmic design).
- Interpret and apply program specifications to determine how a problem can be broken down into front-end and back-end processes.
- Select and use of appropriate languages for each component of the stack.
- Select and use features of the procedural programming paradigm as required by the nature of a problem:
  - local and global variables
  - declaring and calling functions/sub-routines
  - passing data and variables to functions and returning results.
- Select and use features of the object-oriented programming (OOP) paradigm as required by the nature of a problem:
  - the structure of OOP (classes, objects, instances)
  - Inheritance
  - encapsulation and data abstraction
  - polymorphism.
- Select and use tools and libraries to allow user interaction with the program, e.g. console input/output, graphical user interfaces, data visualisation.
- Use of runtime data structures to use and manipulate program data, e.g. list, array, tuple, dictionary.
- The use of local data sources to use and manipulate program data, e.g. .txt, .csv, JSON.
- The use of remote data sources to use and manipulate program data, including:
  - server-side and client-side scripting
  - SQL commands to read from and write to a database
  - use of public application programming interfaces (APIs).

C2 Developing high-quality software solutions

The skills, processes and techniques used to ensure efficient, readable, maintainable and robust software.

- Techniques to ensure readable and maintainable code, including:
  - use of style and layout guides (e.g. tabs, spacing, indents and line length)
  - naming conventions (e.g. meaningful names, upper/lower case and underscores)
  - code annotations/comments
  - modularisation.
- Reuse or refactoring pre-written code, including:
  - built-in functions and standard libraries
  - additional or imported libraries to add functionality (e.g. time-based functions, user interfaces, data handling, Web APIs and frameworks)
  - templates and bootstrapping
  - components from solutions you have previously developed
  - components from collaborative or shared development environments (e.g. internal knowledge base, and Git Hub).

- Use of tools provided by integrated development environments and related code development tools to ensure high quality code, including:
  - code and syntax highlighting
  - code completion
  - interpreter/compiler
  - debugger
  - code management platform/repository (Git) integration.
- Use of appropriate features within a chosen paradigm to ensure reusability, extensibility and robustness.
- Defensive coding techniques, including:
  - input validation
  - input sanitisation
  - data hiding and obfuscation (e.g. fallback states and error messages).
- Ensuring good user experience, including:
  - consistency and clarity of outputs
  - user interface design, (e.g. intuitive, easy to use, inclusion of appropriate media and data visualisation)
  - accessibility considerations.

C3 Testing and reviewing software solutions

Application of processes and techniques to test and review software and ensure a solution is fit for purpose.

- Use of functional requirements, non-functional requirements and key performance indicators to inform testing.
- Develop an initial testing schedule to plan what should be tested and when, including coverage of (as appropriate to the solution):
  - module testing
  - integration testing
  - automated testing
  - user testing and feedback.
- Write test plans and apply appropriate unit test cases (UTCs), including:
  - use of success criteria and KPIs to inform testing
  - identification of the test to be carried out
  - description of the purpose of the test
  - identification of test data to be used (if required) (e.g. valid, valid extreme, invalid, invalid extreme and erroneous).
- Execute UTCs and document results, including:
  - recording any errors generated
  - describing the program outcomes
  - comparing test outcomes to expected outcomes
  - describing any additional actions required.
- Rework the code and UTCs to fix identified defects.
- Record corrective actions for identified defects.
- Key stakeholders from whom to seek feedback on a product:
  - the client
  - software development team, (e.g. line mangers and other developers)
  - test users.

- The use of different methods for gathering feedback, including:
  - black box and white box testing
  - paired programming activities
  - user acceptance testing
  - beta testing.
- Methods to record, analyse and action feedback received to improve a software solution, including (as appropriate):
  - user feedback forms
  - bug reports
  - change logs
  - test log entries
  - versioning and commits.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Explore tools and technologies for full stack development		
A.P1 Describe how full stack programming is used in industry to develop solutions to meet specific identified needs. **A.P2** Explain the associated benefits, drawbacks and wider considerations of full stack development.	**A.M1** Analyse the benefits, drawbacks and wider considerations of using full stack development to develop solutions to meet specific identified needs.	**A.D1** Evaluate the impact of using full stack development to develop solutions to meet specific identified needs.
Learning aim B: Design a full stack solution for an identified client		
B.P3 Produce a proposal and a set of designs for a full stack solution that meets client requirements. **B.P4** Review designs with others to identify and inform improvements.	**B.M2** Refine the proposal and designs in response to feedback, justifying any changes made.	**BC.D2** Evaluate the design and development of a refined full stack solution against identified requirements.
Learning aim C: Develop a full stack solution for an identified client		
C.P5 Produce a full stack solution to meet identified requirements. **C.P6** Test and review a full stack solution to resolve defects.	**C.M3** Use iterative development processes to produce a full stack solution that makes **effective** use of front-end and back-end processes to meet identified requirements.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6 Internal assessment* gives information on setting assignments and there is also further information on our website.

There is a maximum number of two summative assignments for this unit.
The relationship of the learning aims and criteria is:

Learning aim A: (A.P1, A.P2, A.M1, A.D1)

Learning aims B and C: (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- an integrated development environment compatible with chosen programming languages
- cloud deployment environments.

Essential information for assessment decisions

Learning aim A

For Distinction standard, learners will evaluate the use of full stack development providing examples of its use to solve at least three different complex computing problems. Learners will evaluate the use of different tools and stacks, for example why LAMP might have been used instead of DJANGO, and consider how they are used in different contexts.

The evaluation will look at ways that full stack programming is used to solve problems and meet specific objectives, drawing comparisons between uses in different contexts. The evaluation should consider a range of benefits, risks and drawbacks of full stack development.

Overall, the evidence will be logically structured with correct technical terms and written at a high standard including the consistent use of correct grammar and spelling.

For Merit standard, learners will analyse full stack development providing examples of its use to solve at least three different computing problems. Learners will consider the use of different tools and stacks, for example why LAMP might have been used instead of DJANGO, exploring how they are applied in different contexts.

The analysis will look at ways that full stack development is applied to solve problems and meet specific needs. The analysis should consider a range of benefits, risks and drawbacks of full stack development.

Overall, the evidence will be logically structured, technically accurate and easy to understand.

For Pass standard, learners will describe the use of full stack to solve different computing problems. Learners will consider the use of different tools and stacks, exploring how they are applied in different contexts. Learners will identify and explain ways that these tools are applied to solve problems and meet specific needs. Learners should consider the benefits, risks and drawbacks of full stack development.

Overall, the evidence will be logically structured. It may be basic in parts, for example the range of tools may not be extensive, and the risks, benefits and drawbacks may be unbalanced or generic. The evidence may contain minor inaccuracies or omissions.

Learning aims B and C

For Distinction standard, learners will use evidence from their proposal, design documents, testing and the feedback of others to support a comprehensive evaluation of their solution in relation to client requirements. The evaluation will provide value judgements as to the extent to which the refined solution meets identified requirements, and will consider alternative ways that the problem could have been solved, and why the final solution was chosen.

For Merit standard, learners will utilise the feedback of others to refine the quality and appropriateness of their proposal and solution design. Learners will provide evidence of their initial designs, a record of feedback and evidence of how the feedback was considered and implemented. They will provide evidence that includes the initial and refined designs. Learners will provide a justification of any changes made during the design stage with reference to client requirements.

At this level, the proposal and design documentation should be of sufficient quality, clarity and detail so that a third party could, with minimal difficulty, use them to create the proposed solution.

Learners will demonstrate an iterative approach to development and testing to produce a robust full stack solution that makes effective use of the complete deployment stack to meet identified requirements.

Learners should clearly demonstrate how they have ensured that testing has considered functional and non-functional requirements, and a range of testing methodologies should be implemented to ensure the solution is robust, although some minor issues will persist.

Evidence of testing should demonstrate appropriate use of test plans and apply appropriate, detailed unit test cases (UTCs). As part of functional testing, at this level, it would be expected that a range of valid, valid extreme, invalid, invalid extreme, erroneous test data is used to effectively test the solution.

The solution will meet most of the user requirements but the implemented solutions may not be the most efficient.

At this level, the code for the solution will have a logical structure. It will make use of precise logic and programming structures which result in correct outcomes. The solution will handle a range of user errors and rogue inputs to ensure a fairly robust system, but some minor issues may persist. The code will be maintainable by a third party through the use of mostly consistent and appropriate naming conventions, logical organisation; and mostly informative commenting.

The solution will provide a good experience through the use of good quality user interface design, mostly effective input handling; generally informative guidance and messages to the user and mostly effective output formatting.

For Pass standard, learners will produce a proposal as to how they intend to implement a full stack solution to meet the needs of an identified client. The proposal should provide sufficient detail in that a third party would understand the scope of the intended solution and provide approval to continue the process based on its content.

Learners will produce a set of design documentation for a substantial full stack solution that utilises a complete deployment stack. The design documents should clearly show how the problem has been broken down into smaller more easily solvable problems and how solutions will be implemented in a computational way. The designs should include the algorithmic, logic, data and visual designs as appropriate to the proposed solution (see Topic B2 for full scope of design documentation).

Learners should show an understanding of how to reuse content in an appropriate and legal way. Learners will provide evidence of having received feedback on their designs, and will use the feedback to develop their designs accordingly.

At this level, the design documentation must be of a reasonable quality, so that a third party could mostly create the proposed solution, but there may be some minor difficulties due to lack of detail or clarity in places.

Learners will demonstrate an appropriate approach to development and testing of a full stack solution demonstrating that they can implement a full deployment stack to meet identified requirements. Although at this level some errors may persist.

Testing will demonstrate some consideration of functional and non-functional requirements and a range of testing methodologies, but at this level it is likely to be unbalanced, focusing more heavily on functional testing.

There will be basic testing of appropriate test plans and application of unit test cases (UTCs). As part of functional testing, at this level, it would be expected that a range of valid, valid extreme, invalid, invalid extreme, erroneous test data is used but the scope of the testing may mean that some issues persist or only common/obvious errors are considered.

The solution will meet some of the user requirements and may be inefficient.

At this level the code for the solution will have a mostly logical structure. It will make use of some precise logic and programming structures which result in mostly correct outcomes. The code will handle some user errors and rogue inputs but some issues may persist. The code will be mostly maintainable by a third party, through the use of some consistent and appropriate naming conventions, some logical organisation and some informative commenting.

The solution will provide a reasonable user experience, through the use of basic user interface design, some effective input handling, some informative guidance and messages to the user and some effective output formatting.

Learners will provide evidence that they have reviewed the solution with others and will provide evidence of how that feedback was used to develop the solution further.

Links to other units

This unit links to:

- Unit 13: Software Testing
- Unit 4: Programming.

Opportunities to develop transferable employability skills

In completing this unit, learners will have the opportunity to develop a number of transferable employability skills, including:

- planning and time management
- problem solving.

4 Planning your programme

How do I choose the right BTEC International Level 3 qualification for my learners?

BTEC International Level 3 qualifications come in a range of sizes, each with a specific purpose. You will need to recruit learners very carefully to ensure that they start on the right size of qualification to fit into their study programme and that they take the right pathways or optional units to allow them to progress to the next stage.

Some learners may want to take a number of complementary qualifications or keep their progression options open. These learners may be suited to taking a BTEC International Level 3 Certificate or Subsidiary Diploma. Learners who then decide to continue with a fuller vocational programme can transfer to a BTEC International Level 3 Diploma or Extended Diploma.

Some learners are sure of the sector in which they wish to work and are aiming for progression into that sector via higher education. These learners should be directed to the two-year BTEC International Level 3 Extended Diploma as the most suitable qualification.

Is there a learner entry requirement?

As a centre, it is your responsibility to ensure that the learners you recruit have a reasonable expectation of success on the programme. There are no formal entry requirements but we expect learners to have qualifications at or equivalent to Level 2.

Learners are most likely to succeed if they have:

- five International GCSEs at good grades and/or
- BTEC qualification(s) at Level 2
- other appropriate qualifications or achievement at year 11 or age 16 in core subjects.

Learners may demonstrate the ability to succeed in various ways. For example, they may have relevant work experience or specific aptitude shown through diagnostic tests or non-educational experience.

If learners are studying in English we recommend that they have attained at least Level B2 in the Common European Framework of Reference for Languages. Please see resources available from Pearson at www.pearson.com/english

What is involved in becoming an approved centre?

All centres must be approved before they can offer these qualifications – so that they are ready to assess learners and so that we can provide the support that is needed. Further information is given in *Section 8 Quality assurance*.

What level of sector knowledge is needed to teach these qualifications?

We do not set any requirements for teachers but recommend that centres assess the overall skills and knowledge of the teaching team to ensure that they are relevant and up to date. This will give learners a rich programme to prepare them for employment in the sector.

What resources are required to deliver these qualifications?

As part of your centre approval, you will need to show that the necessary material resources and work spaces are available to deliver BTEC International Level 3 qualifications. For some units, specific resources are required.

How can Pearson Progress help with planning for these qualifications?

Pearson Progress is a digital support system that supports the delivery, assessment and quality assurance of BTECs in centres. It supports teachers with activities such as course creation, creating and verifying assignments and creating assessment plans and recording assessment decisions.

For further information, see *Section 10 Resources and support*.

Which modes of delivery can be used for these qualifications?

You are free to deliver BTEC International Level 3 qualifications using any form of delivery that meets the needs of your learners. We recommend making use of a wide variety of modes, including direct instruction in classrooms or work environments, investigative and practical work, group and peer work, private study and e-learning.

What are the recommendations for employer involvement?

BTEC International Level 3 qualifications are vocational qualifications and, as an approved centre, you are encouraged to work with employers on design, delivery and assessment to ensure that it is engaging and relevant, and that it equips learners for progression. There are suggestions in many of the units about how employers could become involved in delivery and/or assessment but these are not intended to be exhaustive and there will be other possibilities at local level.

What support is available?

We provide a wealth of support materials, including curriculum plans, delivery guides, sample Pearson Set Assignments, authorised assignment briefs and examples of marked learner work.

You will be allocated a Standards Verifier early on in the planning stage to support you with planning your assessments. There will be extensive training programmes as well as support from our Subject Advisor team.

For further details see *Section 10 Resources and support*.

Meeting local needs

Centres should note that the qualifications set out in this specification have been developed in consultation with centres and employers for the relevant sector. Centres should make maximum use of the choice available to them within the optional units to meet the needs of their learners, and local skills and training needs.

In certain circumstances, units in this specification might not allow centres to meet a local need. In this situation, Pearson will allow centres to either make use of units from other BTEC specifications in this suite, or commission new units to meet the need. Centre developed units will need to be quality assured by Pearson at a cost. Centres are required to ensure that the coherence and purpose of the qualification is retained and to ensure that the vocational focus is not diluted.

The proportion of imported, or locally developed units that can be used are as follows. These units cannot be used at the expense of the mandatory units in any qualification.

Qualification	Meeting local needs allowance	Unit equivalence
Certificate (180 GLH)	No MLN allowed	0 units
Subsidiary Diploma (360 GLH)	60 GLH MLN allowed	1 * 60 GLH unit
Foundation Diploma (540 GLH)	120 GLH MLN allowed	e.g. 2 * 60 GLH units
Diploma (720 GLH)	180 GLH MLN allowed	e.g. 3 * 60 GLH units
Extended Diploma (1080 GLH)	240 GLH MLN allowed	e.g. 4 * 60 GLH units

How will my learners become more employable through these qualifications?

BTEC International Level 3 qualifications are mapped to relevant occupational standards, please see *Appendix 1*: *Links to industry standards*.

Employability skills, such as teamworking and entrepreneurialism, and practical, hands-on skills have been built into the design of the learning aims and content. This gives you the opportunity to use relevant contexts, scenarios and materials to enable learners to develop a portfolio of evidence that demonstrates the breadth of their skills and knowledge in a way that equips them for employment.

5 Assessment structure

Introduction

BTEC International Level 3 qualifications are assessed using a combination of *internal assessments*, which are set and marked by teachers, and Pearson Set Assignments, which are set by Pearson and marked by teachers.

- Mandatory units will be assessed by Pearson Set Assignments.
- Optional units are internally assessed or assessed by Pearson Set Assignments.

In developing an overall plan for delivery and assessment for the programme, you will need to consider the order in which you deliver units, whether delivery is over short- or long periods and when assessment can take place.

We have addressed the need to ensure that the time allocated to final assessment of units is reasonable so that there is sufficient time for teaching and learning, formative assessment and development of transferable skills.

In administering an internal assignment or a Pearson Set Assignment, the centre needs to be aware of the specific procedures and policies that apply, for example to registration, entries and results. An overview, with signposting to relevant documents, is given in *Section 7 Administrative arrangements*.

Internal assessment

Our approach to internal assessment for these qualifications will be broadly familiar to experienced centres. It offers flexibility in how and when you assess learners, provided that you meet assessment and quality assurance requirements. You will need to take account of the requirements of the unit format, which we explain in *Section 3 Units*, and the requirements for delivering assessment given in *Section 6 Internal assessment*.

Pearson Set Assignment units

A summary of the set assignments for this qualification is given in *Section 2 Structure*. You should check this information carefully, together with the details of the unit being assessed, so that you can timetable learning and assessment periods appropriately.

Learners must take the authorised Pearson assignment for the set assignment unit. Teachers are not permitted to create their own assessments for set assignment units. Some assignments may need to be taken in controlled conditions. These are described in each unit.

Please see *Section 6* for resubmission and retaking regulations.

6 Internal assessment

This section gives an overview of the key features of internal assessment and how you, as an approved centre, can offer it effectively. The full requirements and operational information are given in the *BTEC International Quality Assurance Handbook*. All members of the assessment team need to refer to this document.

For BTEC International Level 3 qualifications, it is important that you can meet the expectations of stakeholders and the needs of learners by providing a programme that is practical and applied. Centres can tailor programmes to meet local needs and use links with local employers and the wider vocational sector.

When internal assessment is operated effectively, it is challenging, engaging, practical and up to date. It must also be fair to all learners and meet international standards.

All units in these qualifications are internally assessed but Pearson sets controlled assessment assignments for some units.

Principles of internal assessment (applies to all units)

Assessment through assignments

For internally-assessed units, the format of assessment is an assignment taken after the content of the unit, or part of the unit if several assignments are used, has been delivered. An assignment may take a variety of forms, including practical and written types. An assignment is a distinct activity, completed independently by learners, that is separate from teaching, practice, exploration and other activities that learners complete with direction from teachers.

An assignment is issued to learners as an assignment brief with a defined start date, a completion date and clear requirements for the evidence that they need to provide. There may be specific observed practical components during the assignment period. Assignments can be divided into tasks and may require several forms of evidence. A valid assignment will enable a clear and formal assessment outcome, based on the assessment criteria. For most units, teachers will set the assignments. For controlled assessment units, Pearson will set the assignment.

Assessment decisions through applying unit-based criteria

Assessment decisions for BTEC International Level 3 qualifications are based on the specific criteria given in each unit and set at each grade level. To ensure that standards are consistent in the qualification and across the suite as a whole, the criteria for each unit have been defined according to a framework. The way in which individual units are written provides a balance of assessment of understanding, practical skills and vocational attributes appropriate to the purpose of qualifications.

The assessment criteria for a unit are hierarchical and holistic. For example, if an M criterion requires the learner to show 'analysis' and the related P criterion requires the learner to 'explain', then to satisfy the M criterion, a learner will need to cover both 'explain' and 'analyse'. The unit assessment grid shows the relationships between the criteria so that assessors can apply all the criteria to the learner's evidence at the same time. In *Appendix 3: Glossary of terms used*, we have set out a definition of terms that assessors need to understand.

Assessors must show how they have reached their decisions using the criteria in the assessment records. When a learner has completed all the assessment for a unit, then the assessment team will give a grade for the unit. This is given according to the highest level for which the learner is judged to have met all the criteria. Therefore:

- to achieve a Distinction, a learner must have satisfied all the Distinction criteria (and therefore the Pass and Merit criteria); these define outstanding performance across the unit as a whole
- to achieve a Merit, a learner must have satisfied all the Merit criteria (and therefore the Pass criteria) through high performance in each learning aim
- to achieve a Pass, a learner must have satisfied all the Pass criteria for the learning aims, showing coverage of the unit content and therefore attainment at Level 3 of the qualification.

The award of a Pass is a defined level of performance and cannot be given solely on the basis of a learner completing assignments. Learners who do not satisfy the Pass criteria should be reported as Unclassified.

The assessment team

It is important that there is an effective team for internal assessment. There are three key roles involved in implementing assessment processes in your centre, each with different interrelated responsibilities; the roles are listed below. There is detailed information in the *BTEC International Quality Assurance Handbook*.

- The Lead Internal Verifier (the Lead IV) has overall responsibility for the programme, its assessment and internal verification, record keeping and liaison with the Standards Verifier, ensuring our requirements are met. The Lead IV registers with Pearson annually. The Lead IV acts as an assessor, standardises and supports the rest of the assessment team, making sure that they have the information they need about our assessment requirements and organises training, making use of our standardisation, guidance and support materials.
- Internal Verifiers (IVs) oversee all assessment activities in consultation with the Lead IV. They check that assignments and assessment decisions are valid and that they meet our requirements. IVs will be standardised by working with the Lead IV. Normally, IVs are also assessors but they do not verify their own assessments.
- Assessors set or use assignments to assess learners. Before making any assessment decisions, assessors participate in standardisation activities led by the Lead IV. They work with the Lead IV and IVs to ensure that the assessment is planned and carried out in line with our requirements.

Effective organisation

Internal assessment needs to be well organised so that the progress of learners can be tracked and so that we can monitor that assessment is being carried out. We support you through, for example, providing training materials and sample documentation. Our online Pearson Progress service can help support you in planning and record keeping. Further information on using Pearson Progress can be found in *Section 10 Resources and support*, and on our website.

It is particularly important that you manage the overall assignment programme and deadlines to make sure that learners are able to complete assignments on time.

Learner preparation

To ensure that you provide effective assessment for your learners, you need to make sure that they understand their responsibilities for assessment and the centre's arrangements.

From induction onwards, you will want to ensure that learners are motivated to work consistently and independently to achieve the requirements of the qualifications. Learners need to understand how assignments are used, the importance of meeting assignment deadlines and that all the work submitted for assessment must be their own.

You will need to give learners a guide that explains how assignments are used for assessment, how assignments relate to the teaching programme and how learners should use and reference source materials, including what would constitute plagiarism. The guide should also set out your approach to operating assessment, such as how learners must submit work and request extensions.

Making valid assessment decisions

Authenticity of learner work

Once an assessment has begun, learners must not be given feedback on progress towards fulfilling the targeted criteria.

An assessor must assess only learner work that is authentic, i.e. learners' own independent work. Learners must authenticate the evidence that they provide for assessment through signing a declaration stating that it is their own work.

Assessors must ensure that evidence is authentic to a learner through setting valid assignments and supervising them during the assessment period. Assessors must take care not to provide direct input, instructions or specific feedback that may compromise authenticity.

Assessors must complete a declaration that:

- to the best of their knowledge the evidence submitted for this assignment is the learner's own
- the learner has clearly referenced any sources used in the work
- they understand that false declaration is a form of malpractice.

Centres can use Pearson templates or their own templates to document authentication.

During assessment, an assessor may suspect that some or all of the evidence from a learner is not authentic. The assessor must then take appropriate action using the centre's policies for malpractice. Further information is given in *Section 7 Administrative arrangements*.

Making assessment decisions using criteria

Assessors make judgements using the criteria. The evidence from a learner can be judged using all the relevant criteria at the same time. The assessor needs to make a judgement against each criterion that evidence is present and sufficiently comprehensive. For example, the inclusion of a concluding section may be insufficient to satisfy a criterion requiring 'evaluation'.

Assessors should use the following information and support in reaching assessment decisions:

- the *Essential information for assessment decisions* section in each unit gives examples and definitions related to terms used in the criteria
- the explanation of key terms in Appendix 3: Glossary of terms used
- examples of assessed work provided by Pearson
- your Lead IV and assessment team's collective experience, supported by the standardisation materials we provide.

Pass and Merit criteria relate to individual learning aims. The Distinction criteria as a whole relate to outstanding evidence across the unit. Therefore, criteria may relate to more than one learning aim (for example A.D1) or to several learning aims (for example DE.D3). Distinction criteria make sure that learners have shown that they can perform consistently at an outstanding level across the unit and/or that they are able to draw learning together across learning aims.

Issuing assessment decisions and feedback

Once the assessment team 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 attainment against criteria has not been demonstrated
- must not provide feedback on how to improve evidence
- must be validated by an IV before it is given to the learner.

Planning and record keeping

For internal processes to be effective, an assessment team needs to be well organised and keep effective records. The centre will work closely with us so that we can ensure that standards are being satisfied and achieved. This process gives stakeholders confidence in the assessment approach.

The programme must have an assessment plan validated by the Lead IV, produced as a spreadsheet. When producing a plan, the assessment team needs to consider:

- the time required for training and standardisation of the assessment team
- the time available to undertake teaching and carry out assessment, taking account of when learners may complete assessments and when quality assurance will take place
- the completion dates for different assignments and the name of each Assessor
- who is acting as the Internal Verifier for each assignment and the date by which the assignment needs to be internally verified

- setting an approach to sampling assessor decisions though internal verification that covers all assignments, assessors and a range of assessment decisions
- how to manage the assessment and verification of learners' work so that they can be given formal decisions promptly
- how resubmission opportunities can be scheduled.

The Lead IV will also maintain records of assessment undertaken. The key records are:

- internal verification of assignment briefs
- learner authentication declarations
- assessor decisions on assignments, with feedback given to learners
- internal verification of assessment decisions
- assessment tracking for the unit.

There are examples of records and further information in the *BTEC International Quality Assurance Handbook*.

Setting effective assignments (applies to all units without Pearson set assignments)

Setting the number and structure of assignments

This section does not apply to set assignment units. In setting your assignments, you need to work with the structure of assignments shown in the *Essential information for assignments* section of a unit. This shows the structure of the learning aims and criteria that you must follow and the recommended number of assignments that you should use. For some units we provide authorised assignment briefs. For all the units, we give you suggestions on how to create suitable assignments. You can find these materials on our website. In designing your own assignment briefs, you should bear in mind the following points.

- The number of assignments for a unit must not exceed the number shown in *Essential information for assignments*. However, you may choose to combine assignments, for example to create a single assignment for the whole unit.
- You may also choose to combine all or parts of different units into single assignments, provided that all units and all their associated learning aims are fully addressed in the programme overall. If you choose to take this approach, you need to make sure that learners are fully prepared so that they can provide all the required evidence for assessment and that you are able to track achievement in the records.
- A learning aim must always be assessed as a whole and must not be split into two or more tasks.
- The assignment must be targeted to the learning aims but the learning aims and their associated criteria are not tasks in themselves. Criteria are expressed in terms of the outcome shown in the evidence.
- You do not have to follow the order of the learning aims of a unit in setting assignments but later learning aims often require learners to apply the content of earlier learning aims and they may require learners to draw their learning together.
- Assignments must be structured to allow learners to demonstrate the full range of achievement at all grade levels. Learners need to be treated fairly by being given the opportunity to achieve a higher grade if they have the ability.

- As assignments provide a final assessment, they will draw on the specified range of teaching content for the learning aims. The specified content is compulsory. The evidence for assessment need not cover every aspect of the teaching content as learners will normally be given particular examples, case studies or contexts in their assignments. For example, if a learner is carrying out one practical performance, or an investigation of one organisation, then they will address all the relevant range of content that applies in that instance.

Providing an assignment brief

A good assignment brief is one that, through providing challenging and realistic tasks, motivates learners to provide appropriate evidence of what they have learned.

An assignment brief should have:

- a vocational scenario, this could be a simple situation or a full, detailed set of vocational requirements that motivates the learner to apply their learning through the assignment
- clear instructions to the learner about what they are required to do, normally set out through a series of tasks
- an audience or purpose for which the evidence is being provided
- an explanation of how the assignment relates to the unit(s) being assessed.

Forms of evidence

BTECs have always allowed for a variety of forms of evidence to be used – provided that they are suited to the type of learning aim being assessed. For many units, the practical demonstration of skills is necessary and, for others, learners will need to carry out their own research and analysis. The units give you information on what would be suitable forms of evidence to give learners the opportunity to apply a range of employability or transferable skills. Centres may choose to use different suitable forms of evidence to those proposed. Overall, learners should be assessed using varied forms of evidence.

Full definitions of types of assessment are given in *Appendix 3: Glossary of terms used*. These are some of the main types of assessment:

- written reports
- projects
- time-constrained practical assessments with observation records and supporting evidence
- recordings of performance
- sketchbooks, working logbooks, reflective journals
- presentations with assessor questioning.

The form(s) of evidence selected must:

- allow the learner to provide all the evidence required for the learning aim(s) and the associated assessment criteria at all grade levels
- allow the learner to produce evidence that is their own independent work
- allow a verifier to independently reassess the learner to check the assessor's decisions.

For example, when you are using performance evidence, you need to think about how supporting evidence can be captured through recordings, photographs or task sheets.

Centres need to take particular care that learners are enabled to produce independent work. For example, if learners are asked to use real examples, then best practice would be to encourage them to use their own or to give the group a number of examples that can be used in varied combinations.

Late completion, resubmission and retakes (applies to all units including Pearson set assignment units

Dealing with late completion of assignments for internally-assessed units

Learners must have a clear understanding of the centre policy on completing assignments by the deadlines that you give them. Learners may be given authorised extensions for legitimate reasons, such as illness at the time of submission, in line with your centre policies.

For assessment to be fair, it is important that learners are all assessed in the same way and that some learners are not advantaged by having additional time or the opportunity to learn from others. Therefore, learners who do not complete assignments by your planned deadline or by the authorised extension deadline may not have the opportunity to subsequently resubmit.

If you accept a late completion by a learner, then the assignment should be assessed normally when it is submitted, using the relevant assessment criteria.

Resubmission of improved evidence for internally-assessed units

An assignment provides the final assessment for the relevant learning aims and is normally a final assessment decision, except where the Lead IV approves one opportunity to resubmit improved evidence based on the completed assignment brief.

The Lead IV has the responsibility to make sure that resubmission is operated fairly. This means:

- checking that a learner can be reasonably expected to perform better through a second submission, for example that the learner has not performed as expected
- making sure that giving a further opportunity can be done in such a way that it does not give an unfair advantage over other learners, for example through the opportunity to take account of feedback given to other learners
- checking that the assessor considers that the learner will be able to provide improved evidence without further guidance and that the original evidence submitted has been authenticated by both the learner and assessor and remains valid.

Once an assessment decision has been given to the learner, the resubmission opportunity must have a deadline within 15 working days after the timely issue of assessment feedback to learners, which is within term time in the same academic year.

A resubmission opportunity must not be provided where learners:

- have not completed the assignment by the deadline without the centre's agreement
- have submitted work that is not authentic.

We recognise that there are circumstances where the resubmission period may fall outside of the 15-day limit owing to a lack of resources being available, for example where learners may need to access a performance space or have access to specialist equipment. Where it is practical to do so, for example evaluations, presentations, extended writing, resubmission must remain within the normal 15-day period.

Retake of internal assessment

A learner who has not achieved the level of performance required to pass the relevant learning aims after resubmission of an assignment may be offered a single retake opportunity using a new assignment. The retake may be achieved at a Pass only.

The Lead Internal Verifier must authorise a retake of an assignment only in exceptional circumstances where they believe it is necessary, appropriate and fair to do so. The retake is not timebound and the assignment can be attempted by the learner on a date agreed between the Lead IV and assessor within the same academic year.

For further information on offering a retake opportunity, you should refer to the *BTEC Centre Guide to Internal Assessment*. Information on writing assignments for retakes is given on our website (www.btec.co.uk/keydocuments).

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, Programme Leaders and Examinations Officers.

Learner registration and entry

Shortly after learners start the programme of learning, you need to make sure that they are registered for the qualification and that appropriate arrangements are made for internal assessment. You need to refer to the *International 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.

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.

Our 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 Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational Qualifications*.

Administrative arrangements for assessment

Records

You are required to retain records of assessment for each learner. Records should include assessments taken, decisions reached and any adjustments or appeals. Further information can be found in the *International 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 takes an assessment. 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 a defined time extension or by adjusting the format of evidence. 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 *Guidance for reasonable adjustments and special consideration in vocational internally assessed units*.

Special consideration

Special consideration is given after an assessment has taken place for learners who have been affected by adverse circumstances, such as illness. You must operate special consideration in line with our policy (see above). You can give special consideration related to the period of time given for evidence to be provided or for the format of the assessment if it is equally valid. You may not substitute alternative forms of evidence to that required in a unit or omit the application of any assessment criteria to judge attainment. Pearson can consider applications for special consideration if they are in line with the policy.

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 *Enquiries and appeals about Pearson vocational qualifications and end point assessment policy*.

Conducting set assignments

Centres must make arrangements for the secure delivery of set assignments.

At least two authorised assignments will be available from September each year. Centres must select the assignment to be taken. Centres must not select an assignment that learners have attempted already.

Each set assignment has a defined degree of control under which it must take place. We define degrees of control as follows.

Medium control

This is completion of assessment, usually over a longer period of time, which may include a period of controlled conditions. The controlled conditions may allow learners to access resources, prepared notes or the internet to help them complete the assignment.

Low control

These are activities completed without direct supervision. They may include research, preparation of materials and practice.

Each set assignment unit will contain instructions in the *Essential information for assignments* section on how to conduct the assessment of that unit.

Some set assignments will need to be taken with limited controls. Limited controls are described in each unit and may include the following conditions:

- Time: each assignment has a recommended time period. This is for advice only and can be adjusted depending on the needs of learners.
- Supervision: you should be confident of the authenticity of learner's work. This may mean that learners be supervised.
- Resources: all learners should have access to the same types of resources to complete the assignment.
- Research: learners should be given the opportunity to carry out research outside of the learning context if required for the assignment.

Schools and colleges must be able to confirm that learner evidence is authentic.

Dealing with malpractice in assessment

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

Pearson does not tolerate actions (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 incidents (or attempted incidents) of malpractice have been proven.

Malpractice may arise or be suspected in relation to any unit or type of assessment within the qualification. For further details regarding malpractice and advice on preventing malpractice by learners, please see Pearson's *Centre guidance: Dealing with malpractice and maladministration in vocational qualifications*, available on our website.

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 and maladministration in vocational qualifications* document gives comprehensive information on the actions we expect you to take.

Pearson may conduct investigations if we believe that 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

Learner malpractice refers to any act by a learner that compromises or which seeks to compromise the process of assessment or which undermines the integrity of the qualifications or the validity of results/certificates.

Learner malpractice in examinations **must** be reported to Pearson using a *JCQ Form M1* (available at www.jcq.org.uk/exams-office/malpractice). The form should be emailed to Learnermalpractice@pearson.com. Please provide as much information and supporting documentation as possible. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice constitutes staff or centre malpractice.

Staff/centre malpractice

Staff and centre malpractice includes both deliberate malpractice and maladministration of our qualifications. As with learner malpractice, staff and centre malpractice is any act that compromises or which seeks to compromise the process of assessment, or which undermines the integrity of the qualifications or the validity of results/certificates.

All cases of suspected staff malpractice and maladministration **must** be reported immediately, before any investigation is undertaken by the centre, to Pearson on a *JCQ Form M2(a)* (available at www.jcq.org.uk/exams-office/malpractice).

The form, supporting documentation and as much information as possible should be emailed to pqsmalpractice@pearson.com. Note that the final decision regarding appropriate sanctions lies with Pearson.

Failure to report malpractice itself constitutes malpractice.

More-detailed guidance on malpractice can be found in the latest version of the document *JCQ General and vocational qualifications Suspected Malpractice in Examinations and Assessments*, available at www.jcq.org.uk/exams-office/malpractice.

Sanctions and appeals

Where malpractice is proven, we may impose sanctions or penalties.

Where learner malpractice is evidenced, penalties may be imposed such as:

- disqualification from the qualification
- being barred 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 you to create an improvement action plan
- requiring staff members to receive further training
- placing temporary blocks on your 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 Heads of Centres (on behalf of learners and/or members of staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in our document *Enquiries and appeals about Pearson vocational qualifications and end point assessment policy*, which is on our website. In the initial stage of any aspect of malpractice, please notify the Investigations Team by email via pqsmalpractice@pearson.com, who will inform you of the next steps.

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 *International Information Manual*. You can use the information provided on qualification grading to check overall qualification grades.

Changes to qualification requests

Where a learner who has taken a qualification wants to resit a unit to improve their qualification grade, you firstly need to decline their overall qualification grade. You may decline the grade before the certificate is issued.

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.

- *BTEC 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.
- *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 and process.

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 qualification.

- Centres must have appropriate physical resources (for example equipment, IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification.
- 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.
- Centres should refer to the *Further information for teachers and assessors* section in individual units to check for any specific resources required.

Continuing quality assurance and standards verification

On an annual basis, we produce the *BTEC 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
- Pearson makes available to approved centres resources and processes that exemplify assessment and appropriate standards. Approved centres must use these to ensure that all staff delivering BTEC qualifications keep up to date with the guidance on assessment
- 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 for BTEC Level 3 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, completed assessed learner work 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 Level 3 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.

9 Understanding the qualification grade

Awarding and reporting for the qualification

This section explains the rules that we apply in awarding a qualification and in providing an overall qualification grade for each learner. It shows how all the qualifications in this sector are graded.

Eligibility for an award

In order to be awarded a qualification, a learner must complete all units, achieve a Pass or above in all mandatory units unless otherwise specified. Refer to the structure in *Section 2 Structure*.

To achieve any qualification grade, learners must:

- complete and have an outcome (D, M, P or U) for all units within a valid combination
- achieve the **required units at Pass or above** shown in *Section 2*, abiding by the minimum requirements in the compensation table below
- achieve the **minimum number of points** at a grade threshold.

It is the responsibility of a centre to ensure that a correct unit combination is adhered to. Learners who do not achieve the required minimum grade (P) in units shown in the structure will not achieve a qualification.

Learners who do not achieve sufficient points for a qualification or who do not achieve all the required units may be eligible to achieve a smaller qualification in the same suite, provided they have completed and achieved the correct combination of units and met the appropriate qualification grade points threshold.

Compensation table

Qualification	Compensation rule	Unit equivalence
Certificate (180 GLH)	No compensation allowed	0 units
Subsidiary Diploma (360 GLH)	Mandatory must be passed, 60 GLH only at U grade permitted from optional	1 * 60 GLH unit
Foundation Diploma (540 GLH)	Mandatory must be passed, 120 GLH only at U grade permitted from optional	e.g. 2 * 60 GLH units OR 1 * 120 GLH unit
Diploma (720 GLH)	Mandatory must be passed, 180 GLH only at U grade permitted from optional	e.g. 3 * 60 GLH units OR 1 * 60 GLH and 1 * 120 GLH unit
Extended Diploma (1080 GLH)	Mandatory must be passed, 180 GLH only at U grade permitted from optional	e.g. 3 * 60 GLH units OR 1 * 60 GLH and 1 * 120 GLH unit

Calculation of the qualification grade

The final grade awarded for a qualification represents an aggregation of a learner's performance across the qualification. As the qualification grade is an aggregate of the total performance, there is some element of compensation in that a higher performance in some units may be balanced by a lower outcome in others.

In the event that a learner achieves more than the required number of optional units, the mandatory units, along with the optional units with the highest grades, will be used to calculate the overall result, subject to the eligibility requirements for that particular qualification title.

BTEC International Level 3 qualifications are awarded at the grade ranges shown in the table below.

Qualification	Available grade range
Certificate, Subsidiary Diploma, Foundation Diploma	P to D*
Diploma	PP to D*D*
Extended Diploma	PPP to D*D*D*

The *Calculation of qualification grade* table, given later in this section, shows the minimum thresholds for calculating these grades. The table will be kept under review over the lifetime of the qualification. In the event of any change, centres will be informed before the start of teaching for the relevant cohort and an updated table will be issued on our website.

Learners who do not meet the minimum requirements for a qualification grade to be awarded will be recorded as Unclassified (U) and will not be certificated. They may receive a Notification of Performance for individual units. The *International Information Manual* gives full information.

Points available for units

The table below shows the number of **points** available for units. For each unit, points are allocated depending on the grade awarded.

	Unit size		
	60 GLH	**90 GLH**	**120GLH**
U	0	0	0
Pass	6	9	12
Merit	10	15	20
Distinction	16	24	32

Claiming the qualification grade

Subject to eligibility, Pearson will automatically calculate the qualification grade for your learners when the unit grades are submitted and the qualification claim is made. Learners will be awarded qualification grades for achieving the sufficient number of points within the ranges shown in the relevant *Calculation of qualification grade* table for the cohort.

Calculation of qualification grade

Applicable for registration from 1 April 2020.

Certificate		Subsidiary Diploma		Foundation Diploma		Diploma		Extended Diploma	
180 GLH		360 GLH		540 GLH		720 GLH		1080 GLH	
Grade	Points threshold	Grade	Points threshold	Grade	Points threshold	Grade	Points threshold	Grade	Points threshold
U	0	U	0	U	0	U	0	U	0
Pass	18	P	36	P	54	PP	72	PPP	108
						MP	88	MPP	124
								MMP	140
Merit	26	M	52	M	78	MM	104	MMM	156
						DM	124	DMM	176
								DDM	196
Distinction	42	D	74	D	108	DD	144	DDD	216
						D*D	162	D*DD	234
								D*D*D	252
Distinction*	48	D*	90	D*	138	D*D*	180	D*D*D*	270

This table is subject to review over the lifetime of the qualification. The most up-to-date version will be issued via our website.

Examples of grade calculations based on table applicable to registrations from April 2020

Example 1: Achievement of a Certificate with a P grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int Set	Pass	12
Unit 5	60	Int	Pass	6
Totals	**180**		**P**	**18**

The learner has sufficient points for a P grade.

Example 2: Achievement of a Certificate with an M grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int Set	Pass	12
Unit 5	60	Int	Distinction	16
Totals	**180**		**M**	**28**

The learner has sufficient points for an M grade.

Example 3: An Unclassified result for a Certificate

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int Set	Unclassified	0
Unit 5	60	Int	Distinction	16
Totals	**180**		**U**	**16**

The learner has a U in Unit 1.

The learner has not met the minimum requirement for a grade in Unit 1.

Examples of grade calculations based on table applicable to registrations from April 2020

Example 1: Achievement of a Subsidiary Diploma with a P grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int Set	Pass	12
Unit 3	90	Int	Merit	15
Unit 6	60	Int set	Merit	10
Unit 9	90	Int	Unclassified	0
Totals	**360**		**P**	**37**

The learner has sufficient points for a P grade.

Example 2: Achievement of a Subsidiary Diploma with an M grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int Set	Pass	20
Unit 3	90	Int	Distinction	24
Unit 6	60	Int set	Merit	10
Unit 9	90	Int	Merit	15
Totals	**360**		**M**	**69**

The learner has sufficient points for an M grade.

Example 3: An Unclassified Result for a Subsidiary Diploma

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int Set	Merit	20
Unit 3	90	Int	Distinction	24
Unit 6	60	Int set	Unclassified	0
Unit 9	90	Int	Merit	15
Totals	**360**		**U**	**59**

The learner has a U in Unit 6.

The learner has sufficient points for an M grade but has not met the minimum requirement for a grade in Unit 6.

Examples of grade calculations based on table applicable to registrations from April 2020

Example 1: Achievement of a Foundation Diploma with a P grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Pass	12
Unit 3	90	Int	Pass	9
Unit 5	60	Int	Pass	6
Unit 6	60	Int set	Merit	10
Unit 7	60	Int	Pass	6
Unit 9	90	Int	Pass	9
Unit 12	60	Int	Pass	6
Totals	**510**		**P**	**58**

The learner has sufficient points for a P grade.

Example 2: Achievement of a Foundation Diploma with an M grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Pass	12
Unit 3	90	Int	Merit	15
Unit 5	60	Int	Distinction	16
Unit 6	60	Int set	Merit	10
Unit 7	60	Int	Merit	10
Unit 9	90	Int	Pass	9
Unit 12	60	Int	Merit	10
Totals	**510**		**M**	**82**

The learner has sufficient points for an M grade.

Example 3: An Unclassified result for a Foundation Diploma

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Pass	12
Unit 3	90	Int	Merit	15
Unit 5	60	Int	Merit	10
Unit 6	60	Int set	Unclassified	0
Unit 7	60	Int	Merit	10
Unit 9	90	Int	Distinction	24
Unit 12	60	Int	Merit	10
Totals	**510**		**U**	**81**

The learner has a U in Unit 6.

The learner has sufficient points for an M grade but has not met the minimum requirement for a grade in Unit 6.

Examples of grade calculations based on table applicable to registrations from April 2020

Example 1: Achievement of a Diploma with a PP grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Pass	12
Unit 3	90	Int	Pass	9
Unit 5	60	Int	Pass	6
Unit 6	60	Int set	Pass	6
Unit 7	60	Int	Merit	10
Unit 9	90	Int	Pass	9
Unit 12	60	Int	Pass	6
Unit 13	60	Int	Pass	6
Unit 14	60	Int	Pass	6
Unit 15	60	Int	Merit	10
Totals	**720**		**PP**	**80**

The learner has sufficient points for a PP grade.

Example 2: An Unclassified result for a Diploma

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Pass	12
Unit 3	90	Int	Merit	15
Unit 5	60	Int	Pass	6
Unit 6	60	Int set	Unclassified	0
Unit 7	60	Int	Merit	10
Unit 9	90	int	Pass	9
Unit 12	60	Int	Merit	6
Unit 13	60	Int	Merit	10
Unit 14	60	Int	Pass	10
Unit 15	60	Int	Merit	10
Totals	**720**		**U**	**88**

The learner has a U in Unit 6.

The learner has sufficient points for an MP grade but has not met the minimum requirement for a grade in Unit 6.

Examples of grade calculations based on table applicable to registrations from April 2020

Example 1: Achievement of an Extended Diploma with a MPP grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Pass	12
Unit 2	90	Int	Pass	9
Unit 3	90	Int	Pass	9
Unit 4	90	Int	Pass	9
Unit 5	60	Int	Pass	6
Unit 6	60	Int set	Pass	6
Unit 7	60	Int	Merit	10
Unit 9	90	int	Pass	9
Unit 10	60	Int	Merit	10
Unit 11	120	Int set	Distinction	20
Unit 12	60	Int	Pass	6
Unit 13	60	Int	Merit	10
Unit 14	60	Int	Merit	10
Unit 20	60	Int	Merit	10
Totals	**1080**		**MPP**	**136**

The learner has sufficient points for an MPP grade.

Example 2: Achievement of an Extended Diploma with a DMM grade

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Distinction	32
Unit 6	60	Int set	Merit	10
Unit 2	90	Int	Pass	9
Unit 3	90	Int	Merit	15
Unit 4	90	Int	Distinction	24
Unit 5	60	Int	Pass	6
Unit 7	60	Int	Merit	10
Unit 9	90	int	Distinction	24
Unit 10	60	Int	Unclassified	0
Unit 11	120	Int set	Pass	12
Unit 12	60	Int	Merit	10
Unit 13	60	Int	Merit	10
Unit 14	60	Int	Merit	10
Unit 20	60	Int	Distinction	16
Totals	**1080**		**DMM**	**188**

The learner has sufficient points for a DMM grade.

Example 3: An Unclassified result for an Extended Diploma

	GLH	Type (Int/Int Set)	Grade	Unit points
Unit 1	120	Int set	Unclassified	0
Unit 2	90	Int	Pass	9
Unit 3	90	Int	Merit	15
Unit 4	90	Int	Merit	15
Unit 5	60	Int	Pass	6
Unit 6	60	Int set	Unclassified	0
Unit 7	60	Int	Pass	6
Unit 9	90	int	Distinction	24
Unit 10	60	Int	Unclassified	0
Unit 11	120	Int set	Distinction	32
Unit 12	60	Int	Merit	10
Unit 13	60	Int	Merit	10
Unit 14	60	Int	Merit	10
Unit 15	60	Int	Pass	6
Totals	**1080**		**U**	**145**

The learner has a U in Units 1 and 6.

The learner has sufficient points for an MMP but has not met the minimum requirement for a grade in Units 1 and 6.

10 Resources and support

Our aim is to give you a wealth of resources and support to enable you to deliver BTEC International Level 3 qualifications with confidence. You will find a list of resources to support teaching and learning, and professional development on our website.

Support for setting up your course and preparing to teach

Specification

The specification (for teaching from April 2020) gives you details of the administration of the qualifications and information on the units for the qualifications.

Pearson Progress

Pearson Progress is a new digital support system that helps you to manage the assessment and quality assurance of the Pearson BTEC International Level 3 IT qualifications. It supports delivery, assessment and quality assurance of BTECs in centres and supports teachers and students as follows:

- course creation
- creating and verifying assignments
- creating assessment plans and recording assessment decisions
- upload of assignment evidence
- tracking progress of every learner

The system is accessible for teachers and learners so that both teachers and learners can track their progress.

Support for teaching and learning

Pearson Learning Services provides a range of engaging resources to support BTEC International Level 3 qualifications, these may include:

- delivery guides, which give you important advice on how to choose the right course for your learners and how to ensure you are fully prepared to deliver the course. They explain the key features of the BTEC International Level 3 IT qualifications, for example employer involvement and employability skills. They also cover guidance on assessment and quality assurance. The Guide tells you where you can find further support and gives detailed unit-by-unit delivery guidance. They include teaching tips and ideas, assessment preparation and suggestions for further resources.
- sample schemes of work are provided for each mandatory unit. These are available in Word™ format for ease of customisation.
- delivery plans that help you structure delivery of a qualification
- teacher resource packs developed by Pearson including materials and activities to fully support your teaching of units available on LearningHub
- digital resources across a range of mandatory and optional units that enable an immersive learning experience available on LearningHub.

LearningHub

Digital learning content for this programme will be available on the Pearson LearningHub. This online and mobile-optimised platform provides high-quality, bitesized digital content for an accessible, interactive learning experience.

https://www.pearson.com/uk/web/learning-hub.html

Teaching and learning resources are also available from a number of other publishers. Details of Pearson's own resources and of all endorsed resources can be found on our website.

Support for assessment

Sample assessment materials for internally-assessed units

For internal units assessed with a Pearson Set Assignment we will provide a sample assignment as an example of the form of assessment for the unit. For the remaining internally set units, we allow you to set your own assignments, according to your learners' preferences and to link with your local employment profile.

We provide a service in the form of Authorised Assignment Briefs and sample Pearson Set Assignments, which are approved by Pearson Standards Verifiers. They are available via our website.

Pearson English

Pearson provides a full range of support for English learning including diagnostics, qualifications and learning resources. Please see www.pearson.com/english

Training and support from Pearson

People to talk to

There are many people available to support you and give you advice and guidance on delivery of your BTEC International Level 3 qualifications. They include the following.

- Subject Advisors – available for all sectors. They understand all Pearson qualifications in their sector and can answer sector-specific queries on planning, teaching, learning and assessment.
- Standards Verifiers – they can support you with preparing your assignments, ensuring that your assessment plan is set up correctly, and support you in preparing learner work and providing quality assurance through sampling.
- Regional teams – they are regionally based and have a full overview of the BTEC qualifications and of the support and resources that Pearson provides. Regions often run network events.
- Customer Services – the 'Support for You' section of our website gives the different ways in which you can contact us for general queries. For specific queries, our service operators can direct you to the relevant person or department.

Training and professional development

Pearson provides a range of training and professional development events to support the introduction, delivery, assessment and administration of BTEC International Level 3 qualifications. These sector-specific events, developed and delivered by specialists, are available both face to face and online.

'Getting Ready to Teach'

These events are designed to get teachers ready for delivery of the BTEC International Level 3 qualifications. They include an overview of qualification structures, planning and preparation for internal assessment, and quality assurance.

Teaching and learning

Beyond the 'Getting Ready to Teach' professional development events, there are opportunities for teachers to attend sector- and role-specific events. These events are designed to connect practice to theory; they provide teacher support and networking opportunities with delivery, learning and assessment methodology.

Details of our training and professional development programme can be found on our website.

Appendix 1: Links to industry standards

Pearson BTEC International Level 3 qualifications have been developed in consultation with industry and appropriate sector bodies to ensure that the content and approach to assessment align closely to the needs of employers. Where they exist, and are appropriate, National Occupational Standards (NOS) and professional body standards have been used to establish unit content. In the IT sector, the following approaches have been used.

ITPS

The Pearson BTEC International Level 3 qualifications in IT have been developed to reflect the underpinning knowledge of the UK Level 3 National Occupational Standards in IT Professional Standards (ITPS) 4.0, to include the range of competencies, knowledge and understanding elements that help learners meet the IT sector skills needs.

Microsoft Computer Science Curriculum

All Level 3 BTEC units in this qualification have been mapped to the Microsoft Computer Science Curriculum, however, as a result of the mapping, Pearson has created new units to fill the gaps. These new units are:

- Unit 21: Introduction to Artificial Intelligence (AI)
- Unit 22: Introduction to Robotics and Automation
- Unit 23: Emerging Trends and Technologies
- Unit 24: Technical Fundamentals for Computing Professionals
- Unit 25: Full Stack Development.

Main learning goals and supplementary learning goals from the curriculum were used as a basis to complete the mapping to existing and new units.

More information on the Microsoft Computer Science Curriculum can be found at https://www.microsoft.com/en-gb/education/lcw/computerscience

Certiport Certifications

Microsoft Fundamentals Certifications

BTEC Units 1 and 10 have been mapped to the certification exam objectives for *Azure Data Fundamentals* (DP-900), while Unit 15 has been mapped to the certification exam objectives for *Azure Fundamentals* (AZ-900). See Appendix 2 for more information.

More resources to support these certifications can be found at https://aka.ms/learn or https://aka.ms/msle and https://certiport.pearsonvue.com/Certifications/Microsoft/MCF/Overview

Information Technology Specialist Certifications

The Information Technology Specialist program is a structured way for learners to validate entry level IT skills sought after by employers. It is aimed at learners who are considering or just beginning a path to a career in Information Technology. The IT Specialist program is available through Certiport and Pearson Vue.

BTEC Units 1, 2, 11, 12 and 15 have been *partially* mapped to various domains covered by IT Specialist certifications offered by Certiport, a Pearson VUE company.

Six IT Specialist certifications have been mapped as follows:

Unit 2: Creating Systems to Manage Information has been partially mapped to the IT Specialist: Databases certification.

Unit 1: Information Technology Systems – Strategy, Management and Infrastructure and ***Unit 15: Cloud Storage and Collaboration Tools*** have been partially mapped to the IT Specialist: Cloud Computing certification.

Unit 1: Information Technology Systems – Strategy, Management and Infrastructure and ***Unit 11: Cyber Security and Incident Management*** have been partially mapped to the IT Specialist: Cyber Security, IT Specialist: Network Security and IT Specialist: Networking certifications.

Unit 1: Information Technology Systems – Strategy, Management and Infrastructure and ***Unit 12: IT Technical Support and Management*** have been partially mapped to the IT Specialist: Device Configuration and Management certification.

Coverage of the remaining content can be found on the Certiport website. To learn more see: https://certiport.pearsonvue.com/Certifications/ITSpecialist/Certification/Overview

NASSCOM

The mandatory units for the three endorsed pathways at Diploma and Extended Diploma have been mapped to NASSCOM qualification profiles for Web Developers, Junior Software Developers, and Software Developers. This means that the BTEC units in these pathways cover the skills and knowledge for their respective occupational standards.

Appendix 2: Microsoft Fundamentals Certifications

This document shows how units in the BTEC International Level 3 qualifications have been aligned to specific Microsoft Fundamentals Certifications.

Microsoft Certified: Azure Data Fundamentals (DP-900)

The Azure Data Fundamentals certification offers the foundation learners need to build technical skills to start working with data in the cloud.

BTEC Units 1 and 10 provide analytical, problem-solving skills and knowledge to prepare learners for the Azure Data Fundamentals exam.

Unit 1: Information Technology Systems – Strategy, Management and Infrastructure examines issues related to the use of IT systems and the impact that they have on organisations and their stakeholders. It explores how IT systems enable organisations to access data, information, and users locally and globally.

Unit 10: Big Data and Business Analytics investigates how and why organisations collect data and the methods used to store and analyse it. It explores a range of methods to present data for different audiences and purposes, and statistical methods used to analyse data.

Microsoft Certified: Azure Fundamentals (AZ-900)

The Azure Fundamentals certification validates learners' knowledge of cloud services and how such services are provided with Azure.

BTEC Unit 15 provides analytical skills and knowledge to prepare learners for the Azure Fundamentals exam.

Unit 15: Cloud Storage and Collaboration Tools explores how different cloud-based technologies can be used to meet a range of clients' needs. It explores the characteristics, benefits, and drawbacks of these technologies considering their impact on individuals and organisations.

Note: The content of some certifications may not be fully covered or may require further study with vendor tools to ensure the learner is fully prepared for the exam.

Further information on how to take any of the Microsoft certification exams or how to cover any of the *remainder* of the content can be found on the Microsoft Learn website: https://www.microsoft.com/en-us/learning/

Examinations may also be available through Pearson Vue: https://home.pearsonvue.com/Clients/Microsoft.aspx

Appendix 3: Transferable employability skills

The need for transferable skills

In recent years, higher-education institutions and employers have consistently flagged the need for learners to develop a range of transferable skills to enable them to respond with confidence to the demands of undergraduate study and the world of work.

The Organisation for Economic Co-operation and Development (OECD) defines skills, or competencies, as 'the bundle of knowledge, attributes and capacities that can be learned and that enable individuals to successfully and consistently perform an activity or task and can be built upon and extended through learning.' [1]

To support the design of our qualifications, the Pearson Research Team selected and evaluated seven global 21st-century skills frameworks. Following on from this process, we identified the National Research Council's (NRC) framework [2] as the most evidence-based and robust skills framework, and have used this as a basis for our adapted skills framework.

The framework includes cognitive, intrapersonal skills and interpersonal skills.

The NRC framework is included alongside literacy and numeracy skills.

The skills have been interpreted for this specification to ensure that they are appropriate for the subject. All of the skills listed are evident or accessible in the teaching, learning and/or assessment of the qualifications. Some skills are directly assessed. Pearson materials will support you in identifying these skills and in developing these skills in learners.

The table overleaf sets out the framework and gives an indication of the skills that can be found in information technology, it indicates the interpretation of the skills in this area. A full interpretation of each skill, with mapping to show opportunities for learner development, is given on the subject pages of our website: qualifications.pearson.com

---

[1] OECD – *Better Skills, Better Jobs, Better Lives* (OECD Publishing, 2012)

[2] Koenig, J. A. (2011) *Assessing 21st Century Skills: Summary of a Workshop* (National Academies Press, 2011)

Cognitive skills	Cognitive processes and strategies	Critical thinking Problem solving Analysis Reasoning/argumentation Interpretation Decision making Adaptive learning Executive function
	Creativity	Creativity Innovation
Intrapersonal skills	Intellectual openness	Adaptability Personal and social responsibility Continuous learning Intellectual interest and curiosity
	Work ethic/ conscientiousness	Initiative Self-direction Responsibility Perseverance Productivity Self-regulation (metacognition, forethought, reflection) Ethics Integrity
	Positive core self-evaluation	Self-monitoring/ self-evaluation/ self-reinforcement
Interpersonal skills	Teamwork and collaboration	Communication Collaboration Teamwork Cooperation Empathy/perspective taking Negotiation
	Leadership	Responsibility Assertive communication Self-presentation

The detailed breakdown of a theme, topic or situation/context in order to interpret or study the interrelationships between parts.

Working with technology in a way that is considerate of wider issues.

Able to communicate intentions clearly, respond appropriately to communications from others, and adapt the tone and content of communication depending on the audience.

Appendix 4: Glossary of terms used

This is a summary of the key terms used to define the requirements in the units.

Term	Definition
Analyse	Learners present the outcome of methodical and detailed examination either: • breaking down a theme, topic or situation in order to interpret and study the interrelationships between the parts and/or • of information or data to interpret and study key trends and interrelationships.
Assess	Learners present a careful consideration of varied factors or events that apply to a specific situation, or identify those which are the most important or relevant and arrive at a conclusion.
Audit	Learners carry out a careful examination and scrutiny of characteristics and/or work undertaken, with a purpose to identify gaps in knowledge, understanding and skills.
Carry out	Learners demonstrate skills, often referring to given processes or techniques.
Compare	Learners identify the main factors relating to two or more items/situations or aspects of a subject that is extended to explain the similarities, differences, advantages and disadvantages.
Complete	Learners finish the necessary task(s) having all the necessary elements.
Create	Learners draw on varied information and use skills to design/develop/produce a specific form of evidence such as a marketing strategy.
Critically (analyse)	Learners give careful analysis and judgement based on information presented.
Demonstrate	Learners' work, performance or practice shows the ability to carry out and apply knowledge, understanding and/or skills in a practical situation.

Term	Definition
Describe	Learners' work gives a clear, objective account in their own words, showing recall and, in some cases application, of the relevant features and information about a subject.
Design	Learners apply skills and knowledge to create a blue print of a functioning product, service or system that is fit for audience and/or purpose.
Develop	Learners acquire and apply skills through practical activities to create a functioning product, service or system that is fit for audience and purpose.
Evaluate	Learners draw on varied information, themes or concepts to consider aspects such as: • strengths or weaknesses • advantages or disadvantages • alternative actions • relevance or significance. Learners' enquiries should lead to a supported judgement showing relationship to its context. This will often be in a conclusion.
Examine (when used in assessment criterion)	Learners select and apply knowledge to less familiar contexts.
Execute	Learners put a plan/process/procedure into effect, which consists of sequential and simultaneous activities/tasks.
Explain	Learners' work shows clear details and gives reasons and/or evidence to support an opinion, view or argument. It could show how conclusions are drawn.
Explore	Learners apply their skills and/or knowledge in contexts involving practical testing or trialling.
Implement (in project management)	Learners plan, execute and monitor the control of a project using an appropriate methodology.
Investigate	Learners' knowledge is based on personal research and development.
Justify	Learners give reasons or evidence to: • support an opinion • prove something right or reasonable.

Term	Definition
Manage	Learners engage with and influence an activity or process.
Monitor	Learners observe and check the progress or quality of (something) over a period of time; keeping under systematic review.
Optimise	Learners improve a process or product/service by incremental steps (including testing) to achieve a better performance (given constraints).
Perform	Learners carry out or execute what has to be done to complete a given activity or to demonstrate personal achievement for an audience.
Plan	Learners create a way of doing a task or series of tasks to achieve specific requirements or objectives, showing progress from start to finish.
Prepare	Learners gather necessary information (through research) in order to make (something) ready for use or consideration.
Present	Learners articulate information to an audience based on the context and relevance to a given situation.
Produce	Learners' knowledge, understanding and/or skills are applied to develop a particular type of evidence, e.g. a plan, product or report.
Recommend	Learners make suggestions or put forward (someone or something) with approval as being suitable for a particular purpose or role. This would be based on prior knowledge and undemanding.
Refine	Learners make minor changes so as to improve or clarify (a theory, method, technique, design, process or a product).
Research	Learners proactively seek information and identify the means and resources to do so. Information should be recorded reviewed and used to inform the: • progress of work • performance or practice.

Term	Definition
Review	Learners make a formal assessment. They appraise existing information or prior events, or reconsider information with the intention of making changes if necessary.
Select	Learners choose the best or most suitable option, whether this is of materials, techniques, equipment or processes. The options and choices should be based on specific criteria.
Solve	Learners find an answer to, explanation for, or means of effectively dealing with a problem.
Specify	Learners state a fact or requirement clearly and precisely, applying relevant information.
Test	Learners take measures to check the quality, performance, or reliability of something, especially before putting it into widespread use or practice.
Understand	Learners demonstrate knowledge related to defined situations.

This is a key summary of the types of evidence and IT-specific terms used for BTEC International Level 3 qualifications.

Type of evidence/IT-specific terms	Definition and purpose
Annotated screen shot	Image copy of a computer screen (obtained by pressing the print screen key then pasting in a document) with added annotations explaining what the image shows.
Case study	A specific example to which all learners must select and apply knowledge. Used to show application to a realistic context where direct experience cannot be gained.
Computer program	A set of instructions in the form of written programming language for certain computer functions.
Database structure	The structure is composed of fields (a single piece of data, e.g. name, date of birth, etc.), records (a complete set of fields, e.g. an employee's personnel record) and tables (a collection of records, e.g. all employees' personnel records).

Type of evidence/IT-specific terms	Definition and purpose
Data dictionary	A centralised repository of information on data, such as meaning, relationships to other data, origin, usage, tables, fields and format.
Design documentation	A plan, diagrams and other information to enable a third party to create a product or system.
Entity-relationship diagram	A diagrammatical representation of database tables and the relationships (and types of relationship) among them.
Evaluate	A review and synthesis of each stage of database design and development processes and outcomes to provide a supported judgement about the quality. Typically, a conclusion will be required.
Event log	A record of a computer's alerts, notifications and/or user activity.
Individual project	A self-directed, large-scale activity requiring, planning, research, exploration, outcome and review. Used to show self-management, project management and/or deep learning.
Normalisation	The process of organising raw data into separate related tables to minimise data redundancy.
Physical computing device/system	Physical devices and components that make up an IT system.
Presentation	Process of presenting a topic area to an audience with an intended purpose, e.g. to inform or to persuade.
Query	An SQL select statement that extracts data from a table or tables which match(es) defined criteria.
Report	A formal document summarising findings, recommendations and solutions of an investigative research. A database report presents information from a database. Information should be displayed simply and efficiently. Printed reports from the database should allow the viewing of information quickly and easily.
Screenshot	A screenshot (sometimes called a screen capture) is an image of a computer screen/monitor that can be saved as a graphics file.

Type of evidence/IT-specific terms	Definition and purpose
Test log	Used to plan and record program testing, record the outcomes of testing and the changes made to solve problems.
User interface	The visual part of the database through which a user interacts with a computer or software. A good interface is intuitive and allows a user to easily enter the required data accurately. A user interface is implemented using screen forms with titles, labelled boxes for data-entry, buttons to perform actions and other features to make interaction as easy as possible.
Video evidence	Evidence displayed on a television screen or monitor, gathered by a camera.

For information about Pearson Qualifications, including Pearson Edexcel, BTEC and LCCI 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

ISBN 978-1-4469-6092-9